THE EFFECT OF DIFFERENT NARCOTICS AND CORONARY OCCLUSION ON THE BLOOD SUGAR LEVEL.

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With 1 Figure in the text.

(Received for publication 20th April 1948.)

In earlier experiments we proved (HAJDU, M. BEZNÁK, RÁDY, 1947) that ligature of the coronary artery caused blood sugar elevation in cats narcotised with an ether which in itself caused no hyperglycaemia. Aether ad narcosim, on the other hand, causes such a marked elevation of the blood sugar (BEZNÁK M., HAJDU 1948) that the eventual hyperglycaemia following coronary ligature can no longer be observed. To continue our experiments we tried to find anaesthetics which in themselves had no influence on the blood sugar and which at the same time did not interfere with the occurrence of hyperglycaemia caused by other influences, chiefly coronary occlusion. That such interference could, however, be expected was shown by the experiments of HUNGERLAND (1936) who found hyperglycaemia in unanaesthetised dogs after the ligature of both femoral or carotid arteries, but found no such elevation of the blood sugar in dogs anaesthetised with morphine-pernocton. Similarly EULER and LILJESTRAND (1934) found no hyperglycaemia after ligature of the carotid in dogs anaesthetised with chloralose. CESARE and BELLINI (1936), on the other hand, found the same hyperglycaemia after heart puncture in guinea pigs anaesthetised with dial as in unanaesthetised ones.

Our present investigation was performed chiefly with chloralose and avertin. Some experiments were also carried out in pernocton anaesthesia, but only in 3 cats anaesthetised with pernocton could the

effect of coronary occlusion be observed, as no more pernocton was available. We also repeated some of our earlier experiments, following the blood sugar level after coronary occlusion in cats anaesthetised with an ether which in itself had no effect on the blood sugar.

METHODS.

Our experiments were carried out on 43 cats of both sexes, weighing 2.2 ± 0.5 kg. Fourteen cats were anaesthetised with chloralose,* 9 with pernocton, 15 with avertin and 5 with ether. The cats fasted 24 hours before the experiment. Chloralose was given dissolved in warm water, 0.1 g/kg b. w. intravenously to cats anaesthetised with ether. 0.6 ml/kg b. w. pernocton and 0.25 ml/kg b. w. avertin was given intraperitoneally, the latter in about 20 times its volume of 37° C water. One cat narcotised with chloralose, 1 with pernocton, and 2 with avertin, died. Difficulties were encountered only in the early stages of avertin anaesthesia, inasmuch as the breathing became very irregular. In such cases we applied artificial respiration by hand for some time, on which the breathing became regular again and no more difficulties were encountered till the end (about 6 hours) of the experiment. Artificial respiration by machine was used only where the chest had to be opened for ligaturing the coronary artery. Blood pressure was not measured. For the blood sugar determination blood was drawn from a branch of the right femoral artery 3 times at 5-minute intervals (in some cats ligature of the coronary was done at this time), 4 times every half hour and 4 times every hour, altogether for 6 hours after the operation. Blood sugar was determined by the modified HAGEDORN-JENSEN method (FUJITA—IWATAKI, 1931).

EXPERIMENTAL RESULTS.

Our results are shown in Figure 1.

Of 13 cats anaesthetised with chloralose 5 served as controls, and the anterior descending branch of the coronary artery was ligatured in eight. It can be seen that chloralose caused a marked hypoglycaemia, and that this hypoglycaemia took place in the same way and degree even after coronary occlusion. It is interesting to note that of the 8 cats none survived coronary ligature for 6 hours, 1 dying 1 hour, one 1½ hours, and the others 4 hours after the operation.

* The chloralose used was a gift from Prof. U. S. v. EULER (Stockholm), for which we are glad to express our gratitude.

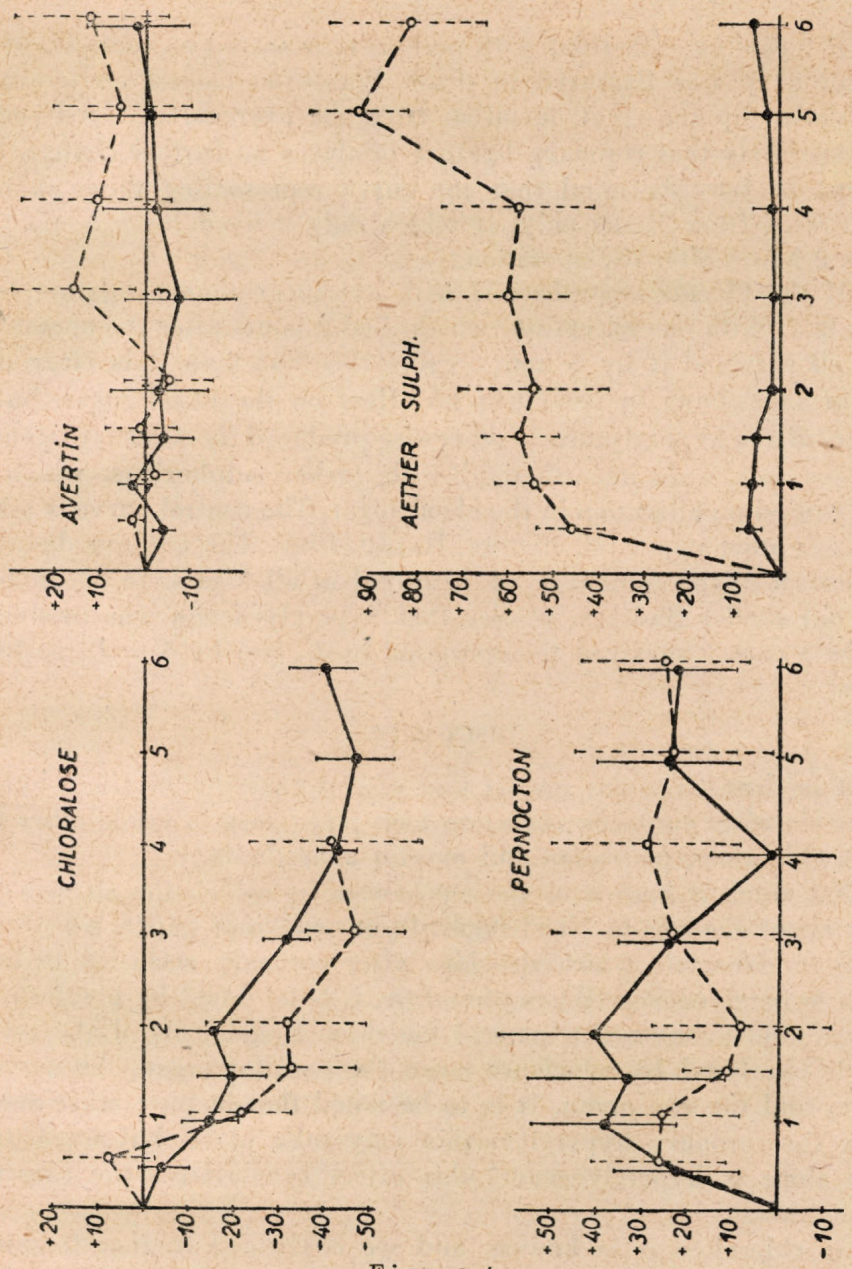

Figure 1.

Blood sugar changes in cats narcotized with different anaesthetics.

Abscissa: Time in hours. Ordinate: Percentual changes in blood-sugar as compared with the initial blood sugar value. Straight line: control experiments, only anaesthesia. Dotted line: Ligature of the descending branch of the anterior coronary artery at 0 hour.

Of 8 cats anaesthetised with pernocton, 5 served as controls, while the coronary was ligatured in three. Pernocton caused an irregular rise (shown by the great deviation from the average) in blood sugar. It seems likely that coronary ligature produces no further change, but it must be born in mind that the curve representing these animals was drawn from 3 cats only, of which only 2 lived for 6 hours, one dying 2 hours after the operation.

Of the 13 cats anaesthetised with avertin, coronary ligature took place in 7. With one exception (which died 2 hours after the operation) they all survived it by 6 hours. From this Figure it is clear that avertin anaesthesia in itself had no effect on the blood sugar, but it prevented the hyperglycaemia otherwise produced by coronary ligature.

Five cats were anaesthetised with aether sulphuricus, which in itself caused no alteration in the blood sugar. The control curve is taken from our other paper (M. BEZNÁK, HAJDU, 1948). The anterior descending branch of the coronary was ligatured in all 5 cats. In accordance with our earlier findings, we see that hyperglycaemia was produced. Of the 5 cats, 2 survived the operation by 6, two by 3 and one by 4 hours.

DISCUSSION.

It is clear from our results that of the anaesthetics tried, hyperglycaemia after coronary occlusion took place only in crude ether but not in chloralose, pernocton and avertin anaesthesia.

Not much is known of the mechanism by which the anaesthetics bring about changes in blood-sugar. In our previous paper, we proved the hyperglycaemia which develops after coronary occlusion to be a reflex hyperglycaemia. When, therefore, it is inhibited by a substance, the question arises which part of the three components of the reflex arch is paralysed, by which we mean the receptor organ, the nervous system and the end organ. It is to be noted that in pure ether anaesthesia the coronary hyperglycaemia may take place, but since pure ether alone is hyperglycaemic, this effect camouflages the presence of the other.

Of chloralose it is known, and we confirmed it, that it causes hypoglycaemia. The reflex producing hyperglycaemia after coronary occulsion cannot overcome the hypoglycaemic effect of chloralose. Chloralose, therefore, paralyses one of the links in the reflex chain. This, according to SATO and OHMI (1933), may be the effector organ, namely the suprarenal medulla, which in chloralose anaesthesia does

not liberate enough adrenaline.. EULER and LILJESTRAND (1934), on the other hand, showed that though no hyperglycaemia followed carotid ligature in dogs anaesthetised with chloralose, the adrenaline level in the blood nevertheless increased after this procedure. This argues for a decreased sensitivity to adrenaline in the blood-sugar liberating organs.

According to the literary data, pernocton either causes a small blood sugar elevation (DIMITRIJEVIC, 1930), or no change at all (MATAKAS, 1932; HELLER and NATHAN, 1933), or, especially after some hours, a small decrease (BRAUCH, 1934). According to the findings of HÜNGERLAND (1936) mentioned introductorily, ligature of the femoral or carotid arteries causes no rise in blood sugar in morphine-pernocton anaesthesia. The mechanism of the inhibition of hyperglycaemia following artery ligature by pernocton is unkown. As HRUBETZ and BLACKBERG (1938) found that other barbiturates (Nembutal, penthotal, seconal, amytal, phenobarbital) decrease the glycogenolytic power of the liver — the effect of 0.25 mg/kg adrenaline given s. c. being much less in rabbits anaesthetised with the above mentioned barbiturates than in normal ones — it might be supposed that pernocton, being also a barbituric acid derivative, would inhibit the hyperglycaemia after coronary occlusion similarly, by decreasing the glycogenolytic power of the liver. Contrary to this hypothesis, however, are HUNGERLAND's findings (l. c.) according to which the blood sugar rise after injection of adrenaline and histamine is unhampered in morphine-pernocton anaesthesia.

NAKAMURA (1935) stated that avertin had hardly any influence on the blood sugar level. We also found this to be the case, but avertin nevertheless inhibited the appearance of hyperglyceamia after coronary ligature.

Up to now only one anaesthetic, crude aether sulphuricus, has been found, which in itself has no effect on the blood sugar level, yet does not influence the hyperglycaemia resulting from coronary occlusion. Crude ether, while it inhibits a hyperglycaemia which pure ether brings about, does not seem to paralyse any member of the reflex chain responsible for coronary hyperglycaemia.

SUMMARY.

1. Chloralose anaesthesia causes hypoglycaemia, pernocton a rather irregular blood sugar rise, whereas avertin does not influence the blood-sugar level.

2. Coronary ligature is not followed by hyperglycaemia in chloralose, pernocton and avertin anaesthesia. In chloralose indeed the same hypoglycaemia takes place as is present without coronary occlusion.

3. Coronary ligature is followed by a hyperglycaemia — tallying with earlier experiments — if cats are anaesthetised with crude ether which in itself causes no blood-sugar elevation.

We would like to thank Prof. A. B. L. BEZNÁK for his continuous interest throughout this work.

MRS. JEAN THOMPSON VASS kindly looked through the English of this paper for which we here express our gratitude.

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