Influence of Calcium on Insulin Secretion in Newborns

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Extract

The effect of calcium and of glucose on insulin secretion was evaluated in neonates. Calcium evoked a prompt and highly significant insulin output, whereas glucose was a poor stimulus.

Speculation

The fact that calcium stimulated insulin release suggests that in neonates the microtubulus-microfilament system in the β -cell is fully developed. In contrast, the glucose-mediated mechanisms for insulin release seem to function only partially.

Introduction

Recent investigations focus on the important role of calcium for the insulin secreting mechanisms (2). It has already been shown that glucose is a poor stimulus for the release of insulin in the newborn (5, 13). Therefore the effect of calcium on the secretion of insulin was studied during the first days of life. It was compared with the effect of glucose. All tests were performed during exchange transfusions with ACD-blood, because the infusion of large doses of calcium is a common practice in this situation and the umbilical vein catheter allows easy blood sampling.

Materials and Methods

The patient material consisted of 8 newborns (5 girls and 3 boys with a birth weight 1720 g and 3700 g). On the second or third day of life they developed hyperbilirubinemia (2 Rh incompatibility, 4 ABO incompatibility, 2 idiopathic hyperbilirubinemia).

The effect of calcium on insulin secretion was studied during exchange transfusions with ACD-blood via the umbilical vein. The glucose concentration in the preserved blood was approximately 300 mg%. For each 100 ml exchanged blood, 2 ml of calcium gluconate solution (10%) were injected as a pulse; in addition, some newborns received 0.33 g/kg bodyweight of glucose as a 20% solution following 160 ml or 260 ml of exchanged blood. Before the injections, after 1 min. and 3 min. serum glucose, calcium and immunoreactive insulin were determined. Glucose was measured with the ferricyanide method adjusted for the autoanalyser, calcium was determined by flamephotometry and insulin by radioimmunoassay according to MELANI et al. (8). Student's t-test was used for statistical analysis.

Results

In the eight newborns 19 calcium injections were performed. According to glucose levels the results were divided into group A (n=8) and group B (n=11). In group A the glucose concentration before the injection of calcium was below 110 mg%, while in group B it was above 110 mg%. In both groups calcium significantly rose to almost identical levels at 1 and 3 minutes after the injection, while glucose decreased at the same time (figure 1). This decrease was only significant in group A. Insulin increased in both groups with a peak at 1 min. following the injection of calcium. In group B the insulin concentration was much higher than in group A.

Contrasting to above findings glucose injections stimulated (n=5) the secretion of insulin in three out of five newborns tested. The mean value of insulin levels in these 5 experiments did not change significantly (table 1).

Discussion

Metabolic and hormonal changes have been reported during exchange transfusions with ACD-blood (9). Citrate stimulates insulin secretion in vitro (10) and the higher insulin concentration at 0 min. (fig. 1, and tab. 1) compared to the fasting state, might be the result of the citrate load infused with the donor blood. In the present study the role of citrate was not investigated, but it may be assumed, that at 1 and 3 minutes after the injection of calcium or glucose, the citrate level did not change since no further donor blood was infused during this short period. In addition direct measurements of citrate in the islets of Langerhans do not support the previously suggested concept that this substrate plays a key role in the insulin secretion (4).

The results reported show that in the newborn calcium is a potent stimulus for the secretion of insulin. Furthermore, the action of calcium is glucose dependent since at higher glucose concentrations far more insulin is released than at glucose concentrations in the normal range. As has been reported for adult rats, glucose regulates the actual calcium concentration in the B-cell (7), which in turn triggers insulin release by interacting with the microtubular microfilament system (6). Since calcium stimulated insulin secretion in all newborns tested, our results indicate that the mechanisms for insulin release connected with the microtubular microfilament systems are fully developed at this age.

In contrast to calcium, glucose was a poor stimulus for insulin release, as has previously been shown (1, 12, 13). In two out of five newborns, it had no effect. Why glucose is such a poor stimulus shortly after birth is only partially known. One reason might be the difference in glucose metabolism in newborn and adult islets of Langerhans (3). Another factor could be the glucose concentration during intrauterine life, since it is well known that in infants of diabetic mothers glucose significantly stimulates insulin secretion (5, 11).

References and Notes

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Figure 1: Effect of calcium, 2 ml 10% calcium gluconate i.v., on serum calcium, glucose and insulin.

*p < 0.05; +p < 0.005 compared to 0 minutes. All other values are not significant. (M. ± S.E.M.)

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15. Accepted for publication December 10, 1972.

time in min.	calcium mval/l	glucose mg%	insulin μ U/ml
0	$4.8 \pm .4$	91 ± 11	74 ± 16
1	$4.3 \pm .5$	$280 \pm 63 +$	69 ± 12
3	$4.6 \pm .5$	$236 \pm 60 +$	69 ± 9

Table 1: Effect of 0.33g/kg glucose i.v. on serum calcium, glucose, and insulin in 5 newborns (n=5).
+ $p < 0.005$ compared to 0 min.
All other values are not significant. ($M \pm S.E.M.$)