The Problem of Insulin Shock Developing at Hyperglycaemic Levels

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In the course of insulin treatment of diabetic coma it has been observed that after a transitory improvement in the patient's state collapse occurred and sensory disorders manifested themselves at a hyperglycaemic level, but after the intravenous administration of glucose immediate improvement set in. In spite of the reduction of the blood sugar level, increased ketosis was a characteristic feature in these cases. After a considerable reduction of the blood ketone level the low blood sugar was tolerated well by the patients [1].

On the basis of clinical observations the occurrence of ketonaemia seemed to be a decisive factor in the development of atypical insulin shock.

The data in the literature are contradictory in regard of the insulin shock developing at normoglycaemic or hyperglycaemic levels [2]. In order to elucidate the problem we have performed animal experiments.

In these experiments we examined the effect of an artificially induced ketonaemic state on the development of hyperglycaemic insulin shock, observing the variations of the blood sugar level under the effect of insulin following artificial ketonaemia. Blood sugar was estimated according to Hagedorn and Jensen. Ketonaemia was induced in rabbits weighing 3 kg each, as already reported [3], by the intravenous injection of sodium acetoacetate, repeated four times at intervals of 30 minutes. The dose of insulin necessary to induce shock was administered after the sodium acetoacetate had caused a considerable rise of the blood sugar level. In part of the experiments simultaneously with the sodium acetoacetate glucose was administered to ensure a high blood sugar value. The results of these experiments are shown in Table I.

In 3 animals with shock it was not possible to inject the glucose in time. These animals died. Necropsy revealed no organic changes in them.

The development of insulin shock at a high blood sugar level in our experimental animals was by no means the result of the insulin-induced fall of the high blood sugar level. If the shock-inducing dose of insulin had been administered intravenously together with 40 ml of 20 per cent glucose to rabbits of the same weight

TABLE I

Insulin Shock in Acetonaemia

No. of animal	Units of insulin	Fasting	Blood Sugar														
			30′	60′	90′	120′	150′	180′	210′	240′	270′	300′	330′	360′	390′	420′	450′
1	80	98↓	115↓	120↓	136↓	170	159	180↓↓	154	124*							
2	32	98↓	115↓	105↓	79↓	82	140	160↓↓	88	79	62	60	60	56	42*		
3	80	88↓	132↓	150↓	136↓	330↓↓	162	145	172	119	105	110	97	79	70	69	65*+
4	24	90↓	145↓	161↓	254↓	240↓↓	156	121	87	69	58	58	54*				
5	32	62↓	148↓	89↓	124↓	169↓↓	158	146	143	100*							
6	64	95↓	148↓	240↓	386↓	350↓↓	208	190	168	140	146*+						
7	120	98↓	188↓	246↓	258↓	220↓↓	156	180	154	132	108	96	60*				
8	120	80↓	251↓	213↓	270↓	232↓↓	158	204	180	164	139*+						
9	32	120↓	177↓	186↓	158↓	166↓↓	134	120	105	92	87	82	94	98*			

* development of shock
↓ time of administration of Na-acetoacetate in a dose of 6.4 g (in Cases 1 to 3, 5.8 g)
↓↓ insulin administration
\+ death
In experiments 3 to 8, 10 ml of 40% glucose was injected intravenously, simultaneously with the administration of acetate.

TABLE II

Insulin Shock after the Combined Intravenous Administration of Glucose and Insulin

Number	Units of Insulin	Fasting	Blood sugar									
			30′	60′	90′	120′	150′	180′	210′	240′	270′	300′
1	32	108↓	366	370	232	135	69	61	45*			
2	32	72↓	382	270	141	76	54	43	32*			
3	64	105↓	200	70	42	27*						
4	80	88↓	420	177	159	165	78	65	58	61	59	34*
5	120	96↓	240	116	68	39*						
6	120	92↓	304	146	78	52	30*					

* Shock.
↓ Time of glucose and insulin administration.

and species, the seizure could be elicited from among 13 cases in 6 only and it always developed in the usual manner at a blood sugar level below 45 mg per 100 ml (Table II). Taking into consideration the blood sugar level at which the seizure appeared, the difference between the two groups, according to the four fields table, was significant ($p<1\%$; excluding the 3 dead animals, $p = 2\%$). This means that simultaneously with the rise of the blood ketone level, insulin shock may develop at a hyperglycaemic level.

According to our clinical observations and animals experiments, the aggravation of the general state observed at blood sugar levels over 100 mg per 100 ml and in the course of insulin treatment, is due to the insulin damage equivalent to hypoglycaemia.

SUMMARY

In rabbits subjected to sodium acetoacetate treatment, insulin shock has been released at hyperglycaemic levels.

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