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Insulin Release and Inhibition of Fore-Stomach Motility in Sheep

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Introduction

The motility of the ruminant fore-stomach is inhibited by volatile fatty acids injected into the rumen (Ash 1959, Stern, Baile and Mayer 1970) or infused intravenously (Le Bars, Lebrument, Nitescu and Simonnet 1954), butyrate being more effective than propionate or acetate. Intravenous butyrate also stimulates secretion of immunoreactive insulin (IRI) and glucagon (IRG) (Bassett 1972), the latter producing a hyperglycaemic response (Jones, Bell, Oyler and Goetsch 1970). We therefore investigated the effect of glucose, insulin and glucagon on the response of the reticulum to butyrate.

Materials and Methods

Three adult female sheep (40-50 kg) were equipped with electrodes for recording reticular motility (Ruckebusch and Tomoy 1973). Sodium butyrate (0.5 mmol/kg body weight; 0.5 M; pH 7.4) was injected into the jugular vein and jugular blood samples taken at intervals of 10-30 min. Similar injections were made 2 h after intravenous injections of glucagon (1 mg *in toto*; Novo) or insulin (3 i.u./kg; Actrapid, Novo), 2 h after the start of a 4-h infusion of glucose (2 mg/kg-min) or saline (2.5 ml/min, 9 g/l) and in alloxan-induced diabetes (70 mg/kg, 3 days previously). Reducing sugar was determined using a Technicon Auto Analyzer and plasma IRI according to Bassett and Thorburn (1971).

Results and Discussion

Table. Effects of butyrate injection at time 0' and glucose infusion on reticulum motility (contractions/h), plasma IRI (μ U/ml) and plasma glucose (mg/100 ml) (mean $\pm$ S.E.M.). * = significant inhibition of motility ($p < 0.05$)

Treatment	n	Reticulum motility		IRI		Glucose	
		-60'-0'	0'-30'	0'	30'	0'	30'
Butyrate in normal sheep	3	45 $\pm$ 5	21* $\pm$ 5	26 $\pm$ 10	103 $\pm$ 9	49 $\pm$ 3	76 $\pm$ 7
Glucose infusion starting at 0'	3	49 $\pm$ 4	32* $\pm$ 5	22 $\pm$ 4	92 $\pm$ 27	49 $\pm$ 3	88 $\pm$ 7
Butyrate during glucose infusion	3	29 $\pm$ 2	4* $\pm$ 1	93 $\pm$ 18	302 $\pm$ 58	100 $\pm$ 7	126 $\pm$ 6
Butyrate after insulin	3	46 $\pm$ 8	30* $\pm$ 2	2621 $\pm$ 1263	2079 $\pm$ 1051	16 $\pm$ 1	43 $\pm$ 8
Butyrate after glucagon	2	51	40	120	225	138	135

Although both butyrate injection and glucose infusion decreased the frequency of reticular contractions (Table), the inhibitory action of butyrate was not related simply to the plasma glucose concentration. Neither insulin nor glucagon injections affected motility directly, although insulin-induced hypoglycaemia has been reported to increase motility (Hill 1954). The butyrate-induced inhibition of motility was absent during alloxan-induced diabetes and was greatly reduced by glucagon injection, but was not significantly changed by insulin injection. The inhibitory action of butyrate on the reticulum, mediated via the parasympathetic nervous system (Ash 1959), may thus be modified by the IRI:IRG ratio. Arginine-induced IRI

release was stimulated and IRG release inhibited by glucose (Gerich, Charles and Grodsky 1974). By analogy, the IRI:IRG ratio after butyrate injection may have been highest during glucose infusion and lowest during alloxan-induced diabetes or following glucagon injection.

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