Small Intestinal Absorption of D-Galactose and Water in Fasted and Alloxan Diabetic Rats

The absorptive capacity of the small intestine of the alloxan diabetic rat for simple sugars is controversial. In vitro studies indicated that absorption was enhanced[1]. On the other hand, studies performed in this laboratory under in vivo conditions showed no consistent increase in simple sugar absorption[2]. However, since intestinal loops tied in situ were used, there was a possibility that mixing of the perfusion solution within the loops may not have been optimal, and as a result, the intestine may not have displayed its maximum absorptive capacity. The present study was designed to determine if use of a pump perfusion method would reveal differences in small intestinal absorption of simple sugars between alloxan diabetic and normal rats under in vivo conditions. The effect of the duration of the diabetic state on absorption was also studied.

Materials and methods. The basic experimental methods and calculations were decribed in a previous communication[2,3]. However, several modifications were introduced. Only 1 sugar, D-galactose, was used in concentrations of 1, 10, 20 and 40 mM/l in Ringer's solution containing 2 g/l of polyethylene glycol (PEG). After preparation of jejunal and ileal segments, the solution was circulated continuously through each segment at a rate 2 ml/min from a 25 ml reservior by an Autoanalyzer proportioning pump (Technician Co., Terrytown, N.Y.).

The following experimental groups were studied: normal rats (unfasted or fasted 24 h) and rats made diabetic with alloxan for 24, 48 and 72 h. All experiments were 1 h in duration. Diabetic rats were deprived of food but not water for 16 h before an experiment.

Results. Normal rats fasted for 24 h absorbed significantly more galactose at all concentrations in both jejunum and ileum than unfasted normals. Water absorption was identical in both groups (Table).

When sugar and water absorption in fasted normal rats was compared to that in 24, 48 and 72 h alloxan diabetic rats, no significant differences were detected. Similarly, there were no differences among the 3 groups of diabetic rats.

Discussion. This study demonstrated that 24 h of fasting significantly enhances D-galactose and water absorption in both jejunum and ileum of normal rats. This agrees with previous in vitro studies[4]. However, alloxan diabetes of up to 72 h duration did not further increase D-galactose or water absorption over that of fasting. These findings are in agreement with our previous in vivo tied loop studies[2] and contrary to the in vitro studies[1] which showed increased absorption in proportion to the length of time the rats were diabetic. Since results with both the perfusion and in situ methods were similar in vivo, the difference from in vitro studies cannot be at-

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Small intestinal absorption of D-galactose and water in normal, fasted and alloxan diabetic rats (Means ± S.D.)[a]

		Jejunal absorption (μM/g wet weight/h)						
	Galactose concentration, (mM/l)	Normal, unfasted	Normal, fasted 24 h[b]	Normal, fasted 48 h[b]	Normal, fasted 72 h[b]	Alloxan diabetic, 24 h[b]	Alloxan diabetic, 48 h[b]	Alloxan diabetic, 72 h[b]
D-Galactose absorption	1	3.6± 0.4	6.2± 0.8	6.0± 0.0	6.1± 1.1	5.1± 1.0	5.8± 1.6	5.2± 0.7
	10	29.6± 3.9	51.8± 6.0	54.0± 8.0	58.6±10.0	43.4± 9.5	49.2± 8.6	51.1± 7.3
	20	57.0± 7.0	91.1± 28.0	89.8±14.0	99.7±11.4	85.4±27.2	79.0±14.9	86.8±14.7
	40	98.2±22.0	153.8±36.0	125.6± 7.6	147.4±37.1	143.6±39.1	135.4±38.2	145.5±29.5
Water absorption	1	0.8± 0.3	0.9± 0.5	1.0± 0.6	0.9± 0.3	1.0± 0.2	1.8± 0.6	1.8± 0.6
	10	1.3± 0.2	1.8± 0.6	1.7± 0.8	1.6± 0.6	1.8± 0.6	2.2± 0.6	2.6± 0.6
	20	1.3± 0.4	1.8± 0.5	1.4± 0.4	1.8± 0.2	2.6± 0.6	2.0± 0.5	2.6± 1.0
	40	1.4± 0.4	1.8± 0.6	1.4± 0.2	1.6± 0.2	2.6± 0.6	2.1± 0.4	2.7± 0.6

		Ileal Absorption (μM/g wet weight/h)						
	Galactose concentration, (mM/l)	Normal, unfasted	Normal, fasted 24 h[b]	Normal, fasted 48 h[b]	Normal, fasted 72 h[b]	Alloxan diabetic, 24 h[b]	Alloxan diabetic, 48 h[b]	Alloxan diabetic, 72 h[b]
D-Galactose absorption	1	2.7± 0.4	3.8± 0.4	4.4± 0.6	4.2± 0.6	4.3± 0.2	4.4± 0.4	4.4± 1.2
	10	13.2± 3.4	29.4± 6.2	28.0± 4.5	32.4± 7.4	27.6± 4.8	28.4± 6.8	35.8± 7.1
	20	28.8± 6.0	54.4± 7.2	48.2± 7.4	50.0± 6.5	52.3± 7.2	60.0±12.4	67.2±11.1
	40	42.8±10.0	95.4±13.8	99.2±17.8	90.8±26.9	96.0±14.2	89.0±16.3	101.1±34.4
Water absorption	1	0.8± 0.3	0.8± 0.6	1.0± 0.2	0.8± 0.2	1.6± 0.6	1.8± 0.2	1.6± 0.8
	10	0.9± 0.3	1.2± 0.1	1.0± 0.6	1.0± 0.1	1.2± 0.4	1.4± 0.4	2.0± 0.6
	20	1.3± 0.2	1.5± 0.5	1.3± 0.6	1.5± 0.4	1.5± 0.2	1.7± 0.7	2.0± 0.3
	40	1.0± 0.4	1.8± 0.4	1.6± 0.2	1.5± 0.4	1.6± 0.6	1.5± 0.4	1.8± 0.4

[a] 8 rats were studied at each concentration. [b] Significantly different from normals ($P < 0.05$).

tributed to methodological artefacts such as poor mixing. Rather, the in vitro state may in some way be responsible for producing enhancement of simple sugar absorption in the alloxan diabetic rat, which does not occur in vivo.

Zusammenfassung. Leerdarm- und Krummdarm-Aufsaugung von D-Galaktose und Wasser wurde mit einer Pumpendurchströmung in vivo bei normalen und Alloxan-diabetischen Ratten geprüft. 24 Stunden Fasten erhöhte die Aufnahmefähigkeit normaler Ratten, ergab aber keinen Unterschied zwischen normalen Ratten beim Fasten und solchen, die mit Alloxan für 24, 48 und 72 Stunden diabetisch wurden.

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The Adrenergically Mediated Coordination of Contraction in Isolated Cell Groups from Rat Ventricular Myocardium

After the classification of adrenergic receptors into α- and β-types[1], it has become established that adrenergic receptors of myocardium are entirely of the β-type[2,3]. However, GOVIER et al.[4] found that the positive inotropic effect can be brought out also by α-adrenergic stimulation of the guinea-pig heart. Recently, techniques have been developed for isolating myocardial cells from adult mammals so that single cells are able to contract rhythmically[5–7]. In the present work the technique of BLOOM[5] was used to study the role of adrenergic receptors in the coordination of contractions of isolated myocardial cells from the rat heart.

Sprague-Dawley rats of both sexes were used; they were 35–37 days old (Experimental Series I) and 7–17 days old (Series II). The latter age group was chosen after the observation that myocardial cells from younger animals functioned more regularly in the experimental conditions. The animals were killed by decapitation; the ventricles were dissected free from the atria and homogenized for 10 sec in a blender at 50,000 rpm in 10 ml of ice-cold homogenizing medium (HM) made according to BLOOM[5]. A sample of one cell group at a time was transferred from the homogenate into fresh HM on a depression slide. Into this HM, the substances to be studied had been added in concentrations given in the Tables. Adrenaline (A) and noradrenaline (NA) were used as stimulators of both α- and β-adrenergic receptors and phenylephrine (PhE) to stimulate primarily the α-receptors[8]. Further, propranolol (Pr) was used as β- and phenoxybenzamine (PBz) as α-receptor antagonist[9]. Experimental Series I was carried out in order to find out how the rhythm of cell contractions was changed during incubation. The average time intervals between successive contractions are shown in Figure 1 and it will be seen that the frequency of the contractions decreased linearly during the period of incubation ($p < 0.025$). Single cells of a cell group usually contracted in an uncoordinated manner, i.e. each cell according to its own rhythm. In some cases, however, the action of the cell group became coordinated so that one cell served as a pacemaker, which started the waves of contractions (Figure 2). As this coordination of contractions seemed to occur more often after an addition of NA, Experimental Series II was carried out in order to study the role of adrenergic receptors in this phenomenon.

Table I shows the effects of various adrenergic agonists, A, NA, and PhE and antagonists, Pr and PBz on the coordination. A, NA and PhE increased the initiation of coordination when compared with the numbers of coordinations in HM ($p < 0.001$, KENDALL's τ-test for 2×2 contingency table). This indicates that adrenergic stimulation induces the initiation of coordination. Pr did not induce the coordination, neither did PBz. To study further the types of adrenergic receptors involved, experiments were performed in which the α- and β-receptors were first blocked with PBz and Pr, respectively, and then stimulated with PhE. The results are in Table II.

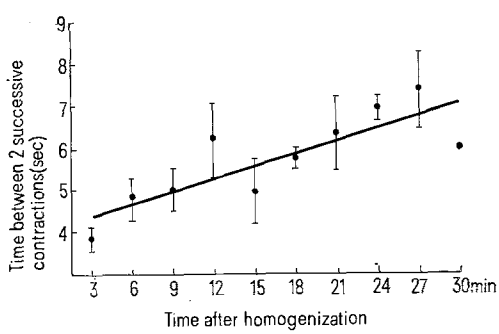

Fig. 1. Changes in the frequency of the uncoordinated contractions of myocardial cells during the incubation in homogenate medium. Abscisse: Time in min after homogenization. Ordinate: Time in sec between 2 successive contractions. Coefficient of regression is 0.049. Vertical bars indicate ± S.E.M.

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