RESEARCH PAPER

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Effect of Combinations of Glucose and Sodium on Absorption in Isolated Rat Intestinal Loops

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Isolated rat intestinal loops were injected with solutions containing Glucose (2%, 4%, 6% or 8%) and Sodium (25, 50, 75 and 100 mEq/l) in 16 permutations. One loop at the mid intestinal region was made per rat and 5 reading were taken for each concentration. At glucose concentrations of 2%, 4%, and 6%, irrespective of the amount of sodium used alongwith, there was absorption. At 8% strength of glucose along with 50, 75 and 100 mEq/l of sodium there was absorption, bearing out the contention that the addition of sodium may cause absorption of glucose even at 8% concentration. However with 8% glucose and 25 mEq of sodium alone, there was secretion. It is concluded that at 8% glucose level, with 50, 75 and 100 mEq/l of sodium, the injected sodium alone, or along with the sodium secreted in the loop is sufficient to absorb glucose, whereas 25 mEq is found insufficient.

ORAL rehydrating solutions (ORS) today form the mainstay of therapy for acute diarrhoea. Solutions with varying concentrations of glucose and sodium are available. The optimal quantity of glucose and sodium in ORS has been a matter of debate for about a decade. Epidemiologists, clinicians and physiologists have argued about the differences between the findings of clinical trials and data derived from studies on isolated membranes in human and animal models.[1] Various animal models with sophisticated instrumentation have been used in many other studies. However, Samant **et al**[2] recently have devised a simple animal model using isolated rat intestinal loops, injected with various concentrations of glucose. They found that 2% and 4% glucose concentrations were absorbed from the loop, while 6% glucose caused secretion into the loop.

In this study, the varying amount of glucose absorption in different areas of the intestines had not been considered. Sovani **et al**[3] repeated this experiment with a slight modification using the latin square design for distribution of various solutions from various loop sites. Absorption was found at 2%, 4%, and 6% glucose and secretion into the loop took place only at 8% glucose concentration. It was suggested that addition of sodium to the solution may help the absorption of glucose even at the 8% concentration. The present investigation was carried out to test this hypothesis.

Materials and Methods

The isolated loop method used in this study was a slight modification of the method used earlier.[4] 80 male albino rats of Wistar strain weighing between 175-200 gms were fasted overnight, but provided with water *ad libitum*. Each rat was anaesthesized using urethane (1.2 g/kg) intraperitoneally, the abdomen was cut open and the intestine was exposed. A loop of 5 cm length was prepared in the middle portion of the intestine. The loop was injected with solutions containing varying concentrations of glucose (2%, 4%, 6% and 8%) and sodium chloride (having 25, 50, 75 and 100 meq/l of sodium). This

Table 1: Mean fluid movement for different solutions

Concentration of sodium in mEq/l	Concentration of Glucose 2%	4%	6%	8%
25	-0.0103 (0.002)	-0.0107 (0.002)	-0.0104 (0.001)	+0.0295 (0.003)
50	-0.0093 (0.003)	-0.0114 (0.002)	-0.0122 (0.002)	-0.0065 (0.003)
75	-0.0127 (0.001)	-0.0108 (0.002)	-0.0045 (0.003)	-0.0069 (0.004)
100	-0.0129 (0.001)	-0.0089 (0.001)	-0.0118 (0.001)	-0.0065 (0.003)

Each value represents the mean difference between the weight of the fluid injected initially in the loop and the residual fluid.
Figures in the parentheses indicate the S.E. of the mean.

led to 16 permutations. For each permutation 5 animals were used.

After filling the loop, the abdomen was carefully covered with cotton swabs moistened with saline to prevent from drying. After 1 hr, the loop was dissected, weighed and its length measured. Then the loop was cut open, allowed to drain, dabbed lightly with a filter paper and weighed again. The weight of the residual fluid in the loop was calculated by subtracting the weight of the empty loop from that of the filled loop. The weight of the injection volume was also determined. All weights were calculated on a per centimetre length of intestine basis for uniformity. Finally weight of the fluid injected initially was substracted from this residual fluid weight. This final figure depending upon whether it was positive or negative, indicated secretion into the loop or absorption respectively. The data was analysed by using two way ANOVA technique, and the post hoc analysis was done using Bonn Ferroni Holmes procedure for multiple comparisons.

RESULTS

Since each solution was tried in 5 rats, the mean of 5 determinations of each solution is shown in **Table-1**. A negative value indicates the amount of fluid absorbed in one hour, while a positive value indicates the amount of fluid secreted into the loop during the same time period. Table 1 shows that at 2%, 4% and 6% strength of glucose along with all strengths of sodium, there was absorption. Solution containing 8% glucose with 25 mEq/l of sodium caused secretion within the loop while at all other strengths of sodium there was absorption.

On analysis using ANOVA, the effect of the interaction of sodium and glucose was found to be significant ($p < 0.001$). Hence comparison of different levels of sodium had to be done separately at each level of glucose and vice versa. The results obtained in the post hoc analysis, using the Bonn Ferroni Holmes procedure for multiple comparisons are presented in Table 2.

Table 2: Post -hoc tests-Boneferroni-Holm Procedure for Multiple Comparisons.

COMPARISON OF MEAN VALUES - DECIMAL ELIMINATED

	GLUCOSE				2%VS		4%VS		6%VS	
	2%	4%	6%	8%	4%	6%	8%	6%	8%	8%
SODIUM 25 µg/L	-1034.38	-1077.80	-1040.00	2947.60	ns	ns	*	ns	*	*
50	-932.80	-1140.00	-1223.40	-656.60	ns	ns	ns	ns	ns	*
75	-1274.40	-1080.60	-451.40	-696.40	ns	*	*	*	*	ns
100	-1296.80	-897.00	-1188.80	-654.00	ns	ns	*	ns	ns	ns
25 VS 50	ns	ns	ns	*						
75	ns	ns	*	*						
100	ns	ns	ns	*						
50 VS 75	ns	ns	*	ns						
100	ns	ns	ns	ns						
75 VS 100	ns	ns	*	ns						

SIGNIFICANCE : ns - Not Singificant (P> 0.05)

* - Significant (P< 0.05)

In case of 2% and 4% glucose, addition of different concentration of sodium did not make a significant difference. In presence of 6% glucose, the solution with 75 mEq/l of sodium was significantly different from the other solution in that it caused lesser absorption from the loop. In presence of 8% glucose the solution with 25 mEq/l of sodium caused secretion, hence was significantly different.

DISCUSSION

The design of this study was different from the earlier one, in that this was not a latin square distribution of solution to loops. Since that would have been unmanageable, only one loop was made per animal and 5 repetitions were carried out for each solution. There was no within animal variation as there was only one loop, and the repetition and fixed site of the loop minimized of the animal to animal variation.

From Table 1 it is apparent that 2%, 4% and 6% glucose solutions are absorbed well from the intestine. This in fact confirms findings of the earlier study.[3] The addition of sodium in these cases may only have ensured absorption since glucose is absorbed only in presence of sodium.[5] At 8% strength of glucose along with 50, 75 or 100 mEq/1 of sodium there is absorption, giving evidence to the contention that addition of sodium may cause absorption of glucose even at 8% concentration.

However, the salient difference is that at 8% glucose there is secretion only with 25 mEq of sodium. It has been suggested that when glucose alone is used, it may lead to sodium secretion first and then absorption of glucose.[3] In the experiment by Lifshitz[1] maximum sodium secretion took place when deionized water was used. In the same study it has been shown that sodium secretion takes place upto around 60 mEq/l of sodium.

In our experiment this would mean that at 8% glucose concentration with 25 mEq of sodium the total amount of sodium secreted plus injected is not sufficient to totally absorb glucose. But at higher concentration of sodium, the amount injected alone or alongwith that secreted into the loop, is sufficient to absorb 8% glucose.

At other strengths of glucose and sodium there have been some statistically significant differences noticed, but since they are only differences in the degree of absorption, they may not be clinically significant.

In an ORS, the concentration of sodium used is between 50 to 90 mEq/l. It is interesting to note that at concentration of sodium between 50 and 100 mEq along with all strengths of glucose there was absorption. This study not only reaffirms the fact that sodium helps absorption of glucose, but it possibly explains why in clinical practice the presently available ORS with glucose concentration from 2-4% are well tolerated.

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