THE UTILIZATION OF INTRAVENOUSLY ADMINISTERED GLUCOSE IN TROPICAL SPRUE

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SUMMARY

1. Rapid intravenous glucose tolerance tests have been carried out in twenty-five patients with tropical sprue who had a flat oral glucose tolerance test. The rate of glucose utilization was determined, and the results compared with a group of twenty-five suitable control subjects. There was no significant difference between the results obtained in the two groups.

2. There was no correlation between the rate of glucose utilization and the maximum rise in the blood sugar level in the oral glucose tolerance test.

3. The flat oral glucose tolerance test in tropical sprue is not attributable to rapid removal of absorbed glucose from the blood stream, and must therefore be due only to defective absorption from the intestine.

The oral glucose tolerance test has frequently been shown to produce a lower rise in blood sugar in people with tropical sprue than in normal subjects (Serr, 1929; Thaysen & Norgaard, 1929; Fairley & Bromfield, 1932; Fairley, 1936; Frazer, 1950; Gardner, 1956; Baker, 1957). Numerous theories have been advanced to account for this finding. The most likely explanation is that it is due to interference with glucose absorption (Rajan et al., 1961). However, the possibility that rapid disappearance of glucose from the blood stream may play a part does not seem to have been fully investigated. This study was undertaken to compare the rate of disappearance of intravenously administered glucose in patients with sprue with that in control subjects.

MATERIALS AND METHODS

Twenty-five subjects with clinical and biochemical features of tropical sprue (Baker, 1957) who had a 'flat' oral glucose tolerance test were studied. Twenty-five subjects of similar socio-economic status and dietary habits, in good health and without any clinical evidence of disease, were used as suitable controls.

Oral glucose tolerance tests were carried out as described previously (Rajan et al., 1961) using a 50 g dose of glucose, and measuring the rise in blood sugar in venous blood samples. Blood sugar levels were estimated by the method of Folin & Wu (1920) modified to give true

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glucose values (King & Wootton, 1956). A maximum rise of 25 mg/100 ml or less was taken as a 'flat' glucose tolerance test.

The rate at which intravenously administered glucose disappears from the circulation was measured by the rapid intravenous glucose tolerance test (Amatuzio et al., 1953). A fasting blood specimen was obtained, and 25 g of glucose dissolved in 80 ml of water, was then injected intravenously as rapidly as possible. The blood glucose level was estimated 5 min after the injection, when adequate mixing had presumably occurred, and this value was taken as the blood concentration at zero time. Subsequently three further estimations were made at exactly 20-min intervals. The fasting level was subtracted from each value, thus giving a figure for the 'glucose excess' in the blood at a given time. If the values so obtained are plotted against the time elapsed on semilogarithmic paper a straight line relationship is obtained (Fig. 1). The slope of this line is reproducible for a given individual, and is not affected by moderate variations in the amount of glucose given.

A relationship of this sort may be represented by the equation:

$$C_t = C_0 e^{-Kt} \quad \text{(Amatuzio et al., 1953)}$$

where $C_t$ = the glucose excess in mg/100 ml at any time $t$, $C_0$ = the glucose excess in mg/100 ml at zero time, and $K$ represents the rate of disappearance of glucose from the blood at any given time.

Let the time taken for the initial glucose excess to be reduced by 50% = $T$

Then by substitution $\frac{1}{2} C_0 = C_0 e^{-KT}$

or

$$K = \frac{\log_e 2}{T}$$

This value of $K$ at the time when the excess concentration of glucose has been reduced by 50% has been termed the 'glucose utilization constant', and is a measure of the rate of glucose utilization by the body.
RESULTS

In the twenty-five control subjects the values of the glucose utilization constant ($K$) ranged from 1.57 to 6.03 with a mean of 3.97 (standard error 0.24). In the sprue patients the range was 2.57–8.15 with a mean of 4.38 (standard error 0.28) (Fig. 2). Although the mean in the patients is slightly higher than in the control group, the difference between the two means is not statistically significant ($t = 1.12$), and it will be seen that this slight increase in the mean is due to only two high values.
The relationship of $K$ to the maximum rise in blood sugar in the oral glucose tolerance test in the spruce patients is shown in Fig. 3. In one patient a flat oral glucose tolerance test is associated with a rapid rate of removal of glucose from the blood stream, but in the group as a whole there is no correlation between the two ($r = 0.13$).

The relationship of $K$ to the severity of the fat absorption defect and to the result of the xylose absorption test was also studied. There was no correlation between the value of $K$ and these two parameters of malabsorption.

**DISCUSSION**

The values for $K$ obtained in our control group are similar to those obtained by other workers (Table 1). Although the nutritional status of our 'normal' subjects was probably very much worse than those of the other series, there is close agreement between the five groups.

<table>
<thead>
<tr>
<th>Table 1. Glucose utilization constant in normal subjects as determined by different authors</th>
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<tbody>
<tr>
<td>Mean</td>
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<tr>
<td>Amatuzio et al. (1953)</td>
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<td>Duncan (1956)</td>
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<td>Martix &amp; Bishop (1957)</td>
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<td>Boyd, Clapp &amp; Finnegan (1962)</td>
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<td>Present study</td>
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The blood sugar levels in the intravenous glucose tolerance test in patients with sprue have been variously reported as being normal (Fairley, 1936; Ross, 1936) and abnormal (Thuyson, 1932). A preliminary investigation from this unit, in which the glucose was administered by intravenous drip, showed a rather flat curve, but the results of the test were not reproducible (B. Pullimood, S. Johnson & S.J. Baker, 1961, unpublished observations). This test was therefore abandoned and the present study undertaken.

The failure to find a statistically significant difference between the value of $K$ in the group of sprue patients and in a group of suitable controls indicates that the low rise in blood sugar in the former cannot be attributed to the rapid utilization of absorbed glucose. The low rise in blood sugar in the oral glucose tolerance test which is found in many patients with tropical sprue must therefore be related only to some unknown defect in glucose transport across the intestinal cells.

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**REFERENCES**


Glucose utilization in sprue


