THE STATUS OF CARBOHYDRATE TOLERANCE TEST BY ORAL AND INTRAVENOUS ADMINISTRATION OF GLUCOSE IN PREGNANCY

by

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Innumerable studies have shown that obstetric complications in a patient prone to diabetes may appear years before the appearance of manifest diabetes. Impaired glucose tolerance is associated with increased maternal and foetal morbidity and particularly perinatal mortality. Thus, early detection remains an important goal in reducing maternal morbidity and increasing foetal salvage.

Many tests have been employed to detect early reduction in the pancreatic reserve of which the commonly used ones are the standard oral and the rapid intravenous glucose tolerance tests. There is no unanimity in the literature regarding the reliability of these tests. Workers like Benjamin and Casper (1967) and Carrington (1964) feel that the oral test is better while Silverstone *et al*, (1963), Occampo *et al*, (1964), Kirk and Lee (1965) and Baker *et al*, (1968) feel that the I.V. G.T.T. is better and more reliable during pregnancy in assessing carbohydrate tolerance.

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Received for publication on 21-4-73.

The present study was undertaken with a view to assess the relative merits of the two tests.

Material and Methods

Cases for the present study were selected from those attending the antenatal clinic of the Irwin Hospital, New Delhi. The non-pregnant controls were selected from patients attending the gynec. out patients department with minor ailments. The cases were divided into 3 groups:

1. Normal non-pregnant group—consisted of 16 patients.
2. Normal pregnant group—comprised of 33 normal pregnant patients in different trimesters of pregnancy.

The patients in the above two groups did not have a family or obstetric history suggestive of diabetes nor were they suffering from any disease or taking any drugs likely to affect the carbohydrate tolerance.

3. Suspect diabetic group—composed of 40 patients in different trimesters of pregnancy.

Criteria of selection included patients with:

1. Unexplained intrauterine deaths or neonatal deaths.
2. Large babies—more than 8 lbs. in weight.

3. Family history of diabetes.
4. Obesity—more than 160 lbs. in weight.
5. History of having given birth to congenitally malformed babies.
6. Glycosuria in the present or past pregnancy.
7. A high fasting or postprandial, blood sugar.
8. History of hydramnios or repeated toxaemias of pregnancy.

Methods

An oral and intravenous glucose tolerance test was performed on all cases with an interval of 3 days. Blood samples were collected for blood sugar estimation. In cases where the results of the oral and I.V. glucose tolerance tests were at variance a prednisolone primed glucose tolerance test (P.G.T.T.) was done by giving 2 doses each of 10 mgm. of prednisolone orally 8½ and 2 hours prior to the test in cases of oral P.G.T.T. and a single dose of 20 mgms. of prednisolone orally 2 hours prior to the test in cases of I.V. P.G.T.T.

The standard oral G.T.T. was used with the following interpretations.

Fasting blood sugar—more than 100 mgm.%, peak value of 160 mgms.% or more and a two hour value exceeding 120 mgms.% was considered abnormal.

The procedure adopted for the I.V. G.T.T. was essentially the same as described by Lundbaek (1962) and Silverstone *et al.* (1963) who have followed the method of Hamilton and Stein (1942).

The I.V. G.T.T. was done by first obtaining a fasting sample of blood and then giving 50 cc. of 50% glucose solution I.V. in 2-4 minutes. Blood samples were then drawn at 10, 20, 30, 40, 50 and 60 minutes with the exact time of withdrawal recorded. The glucose values were then plotted on a semilogarithmic paper and a straight line of descent obtained. The slope gradient of the line was obtained from the formula derived by Amatuzio *et al* and designated 'K' value.

Thus K = 0.693 x 100 mgms. per cent per minute where 't' is the time required for blood glucose to decrease by 50%.

The lower limit for 'K' value for non-pregnant and normal pregnant patients were taken as follows:

Non-pregnant—0.98, normal pregnant—1st trimester 1.37, 2nd trimester—1.18, 3rd trimester—1.13

Prednisolone glucose tolerance test interpreted as follows:

Peak more than 160 mg.%

2 hr. value more than 140 mg.%

Blood sugar estimations (True sugar) were done by the method of King and Asatoor (1954).

Results

The mean glucose disappearance rates obtained during the I.V. G.T.T. in normal non-pregnant, normal pregnant and suspect diabetic patients is shown in Table I.

The intravenous glucose tolerance improved during normal pregnancy and the 'K' value was maximum in the first trimester after which it showed a gradual decline. The I.V. glucose tolerance was impaired in the suspect diabetic patients as compared to normal pregnant patients.

The overall results of oral and I.V. G.T.T. carried out in 89 patients is given in Table II.

Thus, from Tables I and II it is concluded that the oral glucose tolerance test gave false positive results in 17.9% of cases as against 1.12% by I.V. G.T.T.

The results of P.G.T.T. done in patients with discrepancy in the results is shown in Tables III and IV.

TABLE I

Mean Glucose Disappearance Rate During I.V. and G.T.T.

Group	K. Value (Mean ± S.D. with Range)
Normal non-pregnant group	1.568 ± 0.412 (0.80 to 2.47)
Normal pregnant group	
1st trimester	2.22 ± 1.330 (1.88 to 2.56)
2nd trimester	1.92 ± 0.336 (1.50 to 2.56)
3rd trimester	1.88 ± 0.459 (1.15 to 2.71)
Suspect diabetic group	
1st trimester	1.76 ± 0.538 (1.22 to 2.88)
2nd trimester	1.52 ± 0.628 (0.82 to 2.23)
3rd trimester	1.56 ± 0.371 (0.86 to 2.43)

TABLE II

Overall Results of Oral and I.V.G.T.T. Tests

	Number of cases	Percentage
Agreement		
Both negative	59	66.3%
Both positive	8	9%
Disagreement		
Oral positive, I.V. negative	19	21.3%
Oral negative, I.V. positive	3	3.4%

The false negative results were obtained in 1.12% and 3.37%, respectively. Thus, the I.V. G.T.T. gave very low false positive and false negative results.

Tables V, VI and VII show the evaluation of diagnostic tests by degree of association with past obstetric history, complications in present pregnancy and foetal outcome in the suspect diabetic group.

By reviewing the past obstetric history, patients with abnormal intravenous test

TABLE III

Comparison of Results of Oral G.T.T. With I.V. P.G.T.T. in Cases Where Oral G.T.T. Alone Was Positive

Group	No. of cases	No. of cases P.G.T.T. done	Results of positive	I.V.P.G.T.T. negative
Normal non-pregnant	1	1	0	1
Normal pregnant	6	6	1	5
Suspect diabetic	12	12	2	10
Total	19	19	19	16

TABLE IV

Comparison of results of I.V.G.T.T. with Oral P.G T T. in cases where I.V.G.T.T. alone was positive

Group	No. of cases	No. of cases P.G.T.T. done	Results positive	Oral P.G.T.T negative
Normal non-pregnant	0	0	0	0
Normal pregnant	0	0	0	0
Suspect diabetic	3	2	1	1
Total	3	2	1	1

TABLE V

Evaluation of Diagnostic Tests by Degree of Association With Complications in Past Obstetric History in Suspect Diabetic Group

Test evaluation		Abortions	Stillbirths	Macrosomia	Family history of diabetes	Neonatal deaths
Normal oral	(22)	8 (36.36%)	8 (36.36%)	6 (27.26%)	1 (4.54%)	3 (13.63%)
Abnormal oral	(18)	9 (50%)	10 (55.55%)	5 (27.77%)	2 (11.11%)	1 (5.55%)
Normal intravenous	(31)	13 (41.93%)	14 (45.16%)	7 (22.58%)	2 (6.45%)	4 (12.9%)
Abnormal intravenous	(9)	4 (44.44%)	4 (44.44%)	4 (44.44%)	1 (11.11%)	—

TABLE VI

Evaluation of Diagnostic Tests by Degree of Association With Complications in Present Pregnancy in Suspect Diabetic Group

Test evaluation		Av. age in yrs.	Av. parity	Av. gestation in wks.	Obesity	Glycosuria	Toxaemia	Hydramnios	Urinary tract infection	Monilial vaginitis
Normal Oral	(22)	27.4	1.3	27.2	5 (22.72%)	10 (45.40%)	4 (18.18%)	2 (9.09%)	1 (4.54%)	0
Abnormal Oral	(18)	29.3	2.6	25.6	4 (22.22%)	9 (50.0%)	4 (22.22%)	6 (33.33%)	3 (16.66%)	2 (11.11%)
Normal Intravenous	(31)	27.6	1.6	27.4	5 (16.12%)	15 (48.30%)	5 (16.12%)	5 (16.12%)	3 (9.67%)	0
Abnormal Intravenous	(9)	30.6	2.7	23.1	4 (44.44%)	4 (44.44%)	3 (33.33%)	3 (33.33%)	1 (11.11%)	2 (22.22%)

showed increased incidence in three out of five categories.

In a review of the present pregnancy the important clinical maternal complications increased in number and severity with abnormal G.T.T. using the I.V. method.

Foetal outcome was found to have a good correlation with abnormal I.V. tests.

Tables VIII, IX and X show the evaluation of patients with abnormality in both the tests.

Maternal complications were found to increase both in number and severity in patients depicting abnormality in both the tests. Foetal outcome was normal only in 50% showing an excellent correlation.

Discussion

The mean glucose disappearance rate or 'K' value during the I.V. test in non-pregnant and normal pregnant patients in the 1st, 2nd and 3rd trimesters of pregnancy obtained in the present series (Table I) was similar to that reported by Silverstone *et al,* (1963). The values were 1.67, 2.3, 1.88 and 1.86, respectively. The intravenous glucose tolerance was seen to improve during pregnancy and the 'K' value was maximum in the Ist trimester after which it showed a gradual decline. On the other hand, the suspect diabetic group, as anticipated, demonstrated an impairment in the carbohydrate tolerance as shown by the decrease in 'K' value or the rate of disappearance of glucose from the blood.

It was observed that the I.V. test elicited a normal response in more than 65% of the cases where the oral test was abnormal. The results of the oral tests were in agreement with the majority of the cases with abnormal I.V. test. Similar findings were reported by Silverstone *et al,* (1963), Occampo *et al,* (1964) and

TABLE VII

Evaluation of Diagnostic Tests by Degree of Association With Foetal Outcome in Suspect Diabetic Group

Test evaluation		No. of cases delivered	Intra-uterine deaths	Abortions	Average baby wt.	Macrosomia	Congenital malformations	Stillbirths
Normal oral	(22)	14	—	—	6.59 lbs.	2 (14.28%)	0	0
Abnormal oral	(18)	17	1 (5.88%)	1 (5.88%)	6.96 lbs.	5 (29.41%)	1 (5.88%)	1 (5.88%)
Normal intravenous	(31)	22	—	—	6.59 lbs.	2 (9.09%)	0	0
Abnormal intravenous	(9)	9	1 (11.11%)	1 (11.11%)	7.39 lbs.	5 (55.55%)	1 (11.11%)	1 (11.11%)

TABLE VIII

Evaluation of Patients With Abnormality in Both the Oral and Intravenous Glucose in Respect of Past Obstetric History in Suspect Group

No. of cases	Abortions	Still-births	Neonatal deaths	Big babies	Family history of diabetes
6	3(50%)	2 (33.3%)	0	2 (33.3%)	1 (16.6%)

TABLE IX

Evaluation of Patients With Abnormality in Both the Tests in Respect of Complications in Present Pregnancy in Suspect Group

No. of cases	Obesity	Glycosuria	Toxaemia	Hydramnios	Ur. tract infection	Monilial vaginitis
6	2 (33.3%)	4 (66.6%)	3(50%)	3 (50%)	1 (16.6%)	2 (33.3%)

TABLE X

Foetal Outcome in Patients With Abnormality in Both the Tests in Suspect Group

No. of cases	Abortion	I.U.D.	Still births	Neonatal deaths	Big baby	Cong malformation	Foetal survival
6	1 (16.6%)	1 (16.6%)	1 (16.6%)	0	3(50%)	1 (16.6%)	3(50%)

Baker *et al.*, (1968). It can be concluded that there are a large number of positive results with the oral test. However, the sensitivity of the I.V. method to glucose in tolerance must also be considered.

Significantly, the patients with abnormal I.V. tests showed a much higher incidence of maternal complications like toxaemia, hydramnios, monilial vaginitis, etc. during the present pregnancy. The foetal outcome was poor in patients with abnormal I.V. test, the incidence of perinatal deaths, abortions and congenital malformations being much higher. The incidence of macrosomia too was found to be higher and average weight of the baby was increased. When compared to patient with abnormal oral tests, a difference of 193 gms. between the mean body weight of the two groups was observed.

Of the normal pregnant controls, 22 out of 31 had delivered and all had normal deliveries.

A significant point which was noted in the present study was that in patients where both the tests showed abnormality an excellent correlation was found as regards maternal complications and foetal outcome. All the cases with perinatal deaths as well as the lone case with congenital anomaly belonged to this group. Besides, 50% of the patients gave birth to babies weighing more than 8 lbs.

Thus, it was concluded that when both the glucose tolerance tests were abnor-

mal, they correlated better with the foetal outcome as well as complications encountered during the present pregnancy while if considered alone, the I.V. glucose tolerance tests seemed to correlate better.

Thus, the I.V. glucose tolerance test which is a quicker and less time consuming procedure apart from its being an excellent indicator of foetal outcome, is recommended for routine use in obstetric patients for investigation and detection of suspect diabetes.

Summary and Conclusion

Oral and intravenous glucose tolerance tests were carried out on 40 suspect pregnant diabetic patients in different trimesters of pregnancy. Sixteen non-pregnant and 33 normal pregnant patients acted as controls. The intravenous glucose tolerance test correlated well with past obstetric history, complications in the present pregnancy and the foetal outcome. When both the tests were abnormal the correlation was better. The intravenous test is recommended for routine use in obstetric patients for diagnosis of latent diabetes.

Acknowledgement

We are thankful to Dr. (Miss) S. Padmavati, Director-Principal, Maulana Azad Medical College and Associated Irwin & G. B. Pant Hospitals, New Delhi, for allowing us to publish this paper.

References

1. Baker, D. P., Hutchinson, J. R. and Vaughn, D. L.: Obst. & Gynec. **31**: 475, 1968.
2. Benjamin, F. and Casper, D. J.: Am. J. Obst. & Gynec. **97**: 488, 1967.
3. Carrington, E.: Diabetes. **13**: 91, 1964.
4. Hamilton, B. and Stein, A. F.: J. Lab. & Clin. Med. **27**: 491, 1942.
5. King and Asatoor (1954): Quoted by King and Wootton. Microanalysis in Med. Biochem. 3rd ed. J. and A. Churchill Ltd., London, 1958.
6. Kirk, R. and Lee, J. H.: Obst. & Gynec. **26**: 86, 1965.
7. Lundbaek, K.: Brit. Med. J. **1**: 1507, 1962.
8. Occampo, P., Coseriu, V. and Quilligan, E.: Obst. & Gynec. **24**: 58: 1964.
9. Silverstone, F. A., Solomons, E. and Rubricius, J.: Diabetes, **12**: 398, 1963.