AMNIOTIC FLUID GLUCOSE IN NORMAL AND HIGH RISK PREGNANCIES

by

RAJNI DHAR,* M.D.

S. Y. EDULJEE,** D.G.O., M.D.

and

I. N. BHATT,*** M.Sc. (Wisc)

Estimation of foetal maturity assumes great importance in the management of certain high-risk pregnancies such as pre-eclampsia, intrauterine growth retardation, postmaturity and maternal diabetes mellitus. In these diseased states, induction of labour may become necessary in order to save the foetus from an increasingly hypoxic intrauterine environment. Moreover, a majority of our hospital class of patients may not furnish reliable data of their last menstrual period, and in order that the foetus may not be delivered prematurily and succumb later to respiratory complications, the obstetrician has to fall back on certain tests for assessing foetal maturity. The amniotic fluid, by virtue of its ready accessibility, and certain changes in its biochemical constituents at various periods of gestation, has been used to assess foetal maturity. The present study was undertaken to evaluate the usefulness of amniotic fluid glucose estimation as a parameter of foetal maturity and well being in normal and diseased states.

*Senior Resident, L.N.J.P. Hospital, New Delhi.

**Associate Professor, Obstetrics and Gynaecology, M.A.M. College and Assoc. L.N.J.P. Hospital, New Delhi.

***Ex-Assistant Professor, Department of Biochemistry, Maulana Azad Medical College, New Delhi.

Accepted for publication on 17-9-79.

Material and Methods

Glucose content was determined in 118 samples of amniotic fluid obtained between 10th to 42nd weeks of gestation from 110 women attending the antenatal clinic, or admitted in the maternity wards of the L.N.J.P. Hospital, New Delhi. Samples of amniotic fluid in first 20 weeks of gestation were obtained from women seeking pregnancy termination. Amniotic fluid was mainly obtained by transabdominal amniocentesis. In a few patients it was obtained transvaginally. Samples contaminated with blood or meconium were discarded. The samples were kept at 4°C and estimation carried out as soon as possible, usually within 1 to 2 hours of collection. Glucose content of the amniotic fluid was determined by the glucose-oxidase method, a modification based on the procedure of Hugget and Nixon (1957). This method is a highly specific and sensitive method for glucose. No other reducing carbohydrate or non-carbohydrate interferes with the method. It is, thus, a measure of the true glucose content of the fluid.

The maturity indicated by amniotic fluid glucose values was correlated with clinical maturity by the criteria laid down by Usher (1966).

TABLE I
Distribution of Patients in Normal and High-risk Pregnancies

Group	No. of patients	No. of amnio-centesis
Normal pregnancy	43	45
Prolonged pregnancy	16	17
Pre-eclampsia	15	15
Placental insufficiency	15	17
Diabetes mellitus	5	5
Anaemia	12	13
Hydramnios	4	6

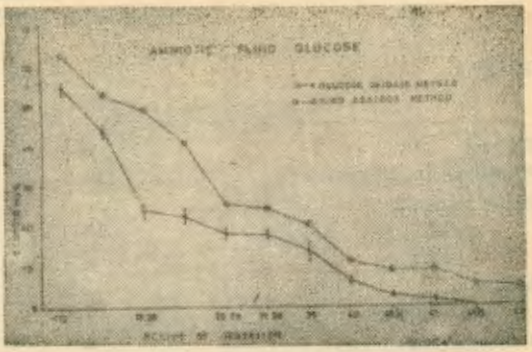

Fig. 1. Shows the relation of amniotic fluid glucose with the period of gestation.

Results

Table II and figure 1 depicts the relation of amniotic fluid glucose (AFG) with period of gestation in normal pregnancy. Amniotic fluid glucose values steadily decline throughout gestation, except for a steeper fall between 16 to 20 weeks and 38 to 41 weeks gestation. Glucose was undetectable in all specimens taken at 42 weeks of gestation by the glucose oxidase method.

TABLE II
Relation of AFG and Period of Gestation

Period of gestation (weeks)	Number of samples	Glucose (mg%) Mean ± S.D.
10-12	2	54.30 ± 3.80
13-16	5	43.46 ± 3.85
17-20	5	24.00 ± 3.84
21-24	5	22.32 ± 3.78
25-28	2	17.95 ± 3.46
33-38	6	18.22 ± 2.73
39	9	13.96 ± 4.50
40	11	6.70 ± 1.87
40	3	3.23 ± 0.32
41	6	1.88 ± 0.60
41	4	0.50 ± 0.20
42	4	0

There were significantly higher values in pregnancies with diabetes mellitus than in normal cases as shown in Table III. On the contrary, the patients with placental insufficiency, pre-eclampsia and moderate to severe anaemia showed significantly lower values as shown in Table IV.

Fig. 2 shows the comparatively lower values of amniotic fluid glucose in these high-risk pregnancies.

In cases of intrauterine death or stillbirth, irrespective of the etiology, AFG values were significantly lower ($p < 0.001$) compared to controls at this period of gestation viz 18.22 ± 2.73 mgm% (Table V).

TABLE III
Comparative AFG (40 Weeks) Pregnancy with Diabetes Mellitus

Group	No. of cases	Mean ± S.D.	t	p
Normal	11	6.70 ± 1.86		
Diabetes mellitus	5	25.05 ± 6.96	7.43	<.001

TABLE IV
Comparative AFG (33-38 Weeks)

Group	No. of cases	Mean ± S.D.	t	p
Normal	6	18.22 ± 2.73		
Placental insufficiency	14	0.78 ± 0.44	22.07	<.001
Pre-eclampsia				
—mild	10	1.31 ± 0.93	16.67	<.001
—severe	5	0	13.49	<.001
Anaemia				
—moderate	7	7.97 ± 0.98	8.53	<.01
—severe	4	0.63 ± 0.10	11.49	<.001

TABLE V
AFG in Intrauterine Deaths and Stillbirths

Period of gestation	Disease complicating pregnancy	Glucose mg%	Weight of foetus (Kg)
34	Placental insufficiency	0.6	2.0
34	Placental insufficiency	0.5	1.4
34	Placental insufficiency	0	0.8
38	Pre-eclampsia	0.5	1.1
34	Hydramnios with anencephaly	2.4	1.7
34	Hydramnios with anencephaly	1.6	1.0

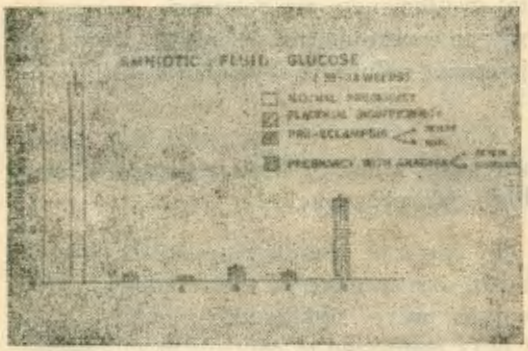

Fig. 2. Shows the comparative amniotic fluid glucose in control and placental insufficiency, pre-eclampsia and pregnancy with anaemia.

Discussion

The quest for a practicable and accurate method for estimation of foetal maturity has stimulated intensive research over the last two decades. Glucose is of outstanding importance in the energy metabolism of the foetus. It acts as a raw material for all the metabolic processes of the foetus. In cases of chronic foetal asphyxia, the glycogen stores could present the metabolic fuel for anaerobic glycolysis. Thus intrauterine estimation of foetal blood glucose in high-risk pregnancies would be of great importance, though this is not as yet feasible. Since the foetus plays an important role in the dynamics and origin of liquor amnii, amniotic fluid glucose could reflect the foetal glucose reserves.

The exact pathway of origin of glucose in amniotic fluid and its dynamics is still unknown. According to Pedersen (1954), Schreiner and Gubler (1963), Drazancic and Kuracic (1974) amniotic fluid glucose, in the presence of normal maternal glycemia, seems to reflect the foetal glucose concentration. In the first trimester, amniotic fluid seems to be a direct exten-

sion of foetal extracellular fluid because the glucose levels in amniotic fluid are high, as in the maternal (and foetal) blood.

The raised amniotic fluid glucose in early gestation reflects the inability of foetal liver to store glycogen and regulate blood glucose concentration upto 15 weeks of gestation. This causes increased leakage of glucose into the liquor amnii. As soon as the foetal liver is fully active, the surplus glucose is stored as glycogen, with the result that amniotic fluid glucose falls, as is evident from Table II. This relation is seen even in abnormal pregnancy. In the present study all the samples at 42 weeks gestation were free of glucose. Spellacy *et al* (1973) ascribe this fall as being due to the maturation of kidney tubules so that more of the glomerular filtered glucose is reabsorbed and consequently less glucose appears in the amniotic fluid.

Significantly higher AFG values were obtained in the 5 cases of diabetes mellitus in the present study (Table III), even though the disease was well controlled in 2 of them.

Pederson (1954) has explained it on the basis of lower 'amniotic sugar threshold' in diabetics than in the non-diabetics. Thus, even if maternal glycemia is the same in the 2 groups, more sugar is excreted in the amniotic fluid of diabetics. According to Wood and Sherline (1975) there may be a 'foetal renal threshold' for glucose which would present as a loss of glucose in the amniotic fluid via urine. It seems likely that maternal and foetal hyperglycemia would be reflected in increased release of glucose in amniotic fluid via foetal kidney, thus causing higher concentration in amniotic fluid.

Significantly lower values of amniotic fluid glucose were obtained in pre-eclampsia, placental insufficiency and moderate to severe anaemias; $p < .001$ (Fig. 2). These diseases are associated with a state of chronic foetal distress or hypoxia. The carbohydrate reserves of the foetal liver have experimentally been shown to be considerably lower in cases of intrauterine death by Oh *et al* (1970) and in hypoxic states by Wood and Sherline (1963) and Dawes *et al* (1959). This may explain low glucose concentration in the amniotic fluid in placental insufficiency, pre-eclampsia and post-maturity. Palliez *et al* (1970) and Drazancic and Kuracic (1974) also reported lower values in hypertensive pregnancies for the corresponding period of gestation. They also found very low or even undetectable values in pregnancy with intrauterine growth retardation. Glucose content was shown to be considerably lower in cases of intrauterine death and stillbirths (Table V). The depletion of liver glycogen stores in stillbirths and intrauterine death was shown by Shelley (1964), Scott (1965) and Oh *et al* (1970). In cases of mild anaemia in the present study there was no significant difference in amniotic fluid glucose values. However, the lower values observed in cases of moderate to severe anaemia may have been contributed to by the associated placental insufficiency in these cases.

In conclusion, estimations of glucose in amniotic fluid in normal pregnancy can serve as a fairly good parameter of foetal maturity. It correlates well with the maturity judged by Usher *et al's* (1966) criteria. In high-risk pregnancy, low or undetectable values are indicative of foetal jeopardy. A more intensive study is necessary before this parameter can be evaluated for assessing foetal maturity and well-being. Since it is a less time consuming method, it can be used in high-

risk pregnancies to exclude foetal jeopardy.

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