Diabetes mellitus is the most frequently occurring endocrine disorder of pregnancy and, since the advent of insulin, diabetes is one of the leading complications of pregnancy. However, recent advances have enabled the pregnant diabetic female to attain an optimal state which, in most cases, may approach that of the population at large.

The purpose of this article is twofold: to acquaint the reader with some of the effects of diabetes on the fetomaternal complex and to illustrate the methods of euglycemic control in the diabetic gravida.

A case history

The following case, based on a retrospective of files, serves as an excellent illustration of the consequences of maternal hyperglycemia on the neonate.

The patient, 45-years-old, gravida 7, para 6, class C diabetic (11 years), had a past medical history that included a cesarean section, trace history of alpha thalassemia, idiopathic hypertrophic subaortic stenosis, Klebsiella pneumonia with septicemia and an allergy to pork insulin. Medications included insulin (beef), cefoxitin, and iron. Average blood pressure (BP) was 140/80.

She was virtually hospitalized throughout the last two months of pregnancy to control her hyperglycemia and to decrease her state of polyhydramnios. There were improvements in both conditions. The majority of blood sugars were in the 100-110 mg/dl range. When the fetus had achieved a mature L/S (Lecithin/sphingomyelin) ratio and when the gestational age was approximately 38 weeks, the patient underwent an elective cesarean section.

Serum glucose drawn the morning of the procedure was 88; no insulin was given that morning. An intravenous solution of Ringer's lactate was ordered by the obstetrician but apparently D5 Ringer's solution was started 1½ hours preoperatively. Epidural anesthesia proved unsuccessful and general endotracheal anesthesia was induced with thiopental and succinylcholine in the usual rapid sequence.

The elapsed time between induction and cord clamping was less than 5 minutes. Delivery produced a depressed infant with Apgar scores of 1 and 5.

Anesthesia was maintained after the delivery with meperidine, nitrous oxide, and succinylcholine via the drip method. The cesarean section was further complicated by significant intraoperative bleeding and hypotension (BP, 80/60). The mother's blood pressure rose to above 100 after a rapid infusion of fluids. Fluid replacement intraoperatively included 1900 ml of Ringer's lactate and 500 ml of D5 Ringer's lactate (administered
after the delivery. The mother’s Dextrostix measurement one-half hour post delivery was 90.

The postoperative course for the mother included blood cell replacement with 2 units of packed cells for a hematocrit of 25.6. The immediate postoperative glucose reading was 291 mg/dl.

The neonate was transferred to the new-born special care unit in fair condition with a diagnosis of neonatal asphyxia and IDM (infant of a diabetic mother.) The baby was placed on 40% oxygen. The initial Dextrostix reading was 90+ on admission and dropped to 25+ approximately ½ hour later. Oral glucose feedings failed to raise the Dextrostix above the 40s. Consequently, the administration of an IV with 10% glucose was necessary until formula feedings became established. Oxygen was discontinued the following day. Mother and child were discharged without further complications.

The effects of pregnancy on diabetes

Diabetes is a multifaceted syndrome characterized by hyperglycemia. For women who are pregnant and diabetic, a classification system developed by White is a useful guide for the clinician (Table 1).8

Pregnancy is said to have a diabetogenic effect secondary to peripheral resistance to insulin, to increased degradation of insulin by the placenta, to increased levels of human chorionic somatomammotrophin (human placental lactogen), and to reduced insulin synthesis.1,2,8 The incidence of diabetic pregnancy is about 1:1,000; however, one study has put the incidence of mild diabetes in pregnancy as high as 1:116.2

The effects of diabetes on pregnancy

Diabetes in pregnancy has a profound impact on the fetomaternal complex. There is an increased risk of intrauterine and perinatal death primarily due to an increased frequency of pregnancy-induced hypertension (toxemia), polyhydramnios, and urinary tract infections.8 Also significant is the increased risk of congenital malformations (caudal regression syndrome),4 macrosomia (large babies),2 hypocalcemia, hyperbilirubinemia, RDS,1 and hypoglycemia in the neonate.8

The more immediate concerns of hypoglycemia and macrosomia are directly related to hyperglycemia in the mother. Glucose is transported to the fetus by facilitated diffusion, whereas maternal insulin does not cross the placental barrier.5,8 This gives rise to fetal hyperinsulinism. Upon delivery, the withdrawal of maternal glucose results in neonatal hypoglycemia. Fetal macrosomia also results from hyperinsulinism and hyperglycemia.

A secondary factor in the infant’s large size is increased glycogen and triglyceride deposits in fetal fat cells (not edema).8 This gives rise to mechanical difficulties at birth such as shoulder dystocia, which may necessitate a cesarean section.

Management of the pregnant diabetic

Optimal control of blood glucose levels between 60 and 120 mg/dl is the objective of management.8 Mean glucose in the normal pregnancy is 86 mg/dl and the normal fasting glucose is 70 mg/dl (3rd trimester). According to Spellacy, a range of 60-80 mg/dl fasting glucose is recommended. Although that range may seem low, there is no apparent concrete evidence to indicate that low glucose is damaging to the fetus.6 However, we do know that hyperglycemia has deleterious effects.

Hospitalization of the patient should occur by approximately the 34th week of pregnancy so as to ensure control of the diabetes. The most successful regimen for insulin administration consists of

<table>
<thead>
<tr>
<th>Class</th>
<th>Age of onset</th>
<th>Duration of diabetes</th>
<th>Vascular disease</th>
<th>Insulin</th>
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<tr>
<td>A</td>
<td>Adult</td>
<td>Pregnancy only</td>
<td>Nil</td>
<td>Occasional</td>
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<td>B</td>
<td>After age 20</td>
<td>10 years</td>
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<td>C</td>
<td>10-19 years</td>
<td>10-19 years</td>
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<td>Yes</td>
</tr>
<tr>
<td>D</td>
<td>Before age 10</td>
<td>Excess of 20 years</td>
<td>Benign retinopathy</td>
<td>Yes</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Nephropathy</td>
<td>Yes</td>
</tr>
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<td>F</td>
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</tr>
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<td>R</td>
<td></td>
<td></td>
<td>Heart disease</td>
<td>Yes</td>
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<td>H</td>
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two injections daily. In the morning, a dose of iso-
phane insulin suspension (NPH) and regular in-
sulin in a ratio of 2:1 respectively is given; in the
evening, equal amounts of NPH and regular insu-
lin are used. It should be noted that oral hypo-
glycemics tend to increase fetal hyperinsulinemia.

Delivery is usually instituted by the 38th
week because by that time, the L/S ratio should be
within acceptable levels. Beyond this time, the
risk of intrauterine death increases. Mode of de-
ivery is not the critical issue; however, conditions
such as hypertension, a biparietal diameter >10,
and a history of previous stillbirths may indicate
the need for a cesarean section. Also, if the mother
is an older diabetic with progressive disease, a
cesarean section may be the preferred method.¹

Management of labor and delivery is impor-
tant for two reasons. First, initial experiments
show that the fetus is less capable of survival if it
is made hypoxic in a hyperglycemic milieu.²
Second, as mentioned before, hyperglycemia in the
mother will probably yield a hypoglycemic neon-
ate. Management of maternal euglycemia is diffi-
cult and a multitude of opinions exist as to how
to achieve this goal.

The simplest protocol is administering ½ to
2⁹ of the normal dose of insulin on the day of
delivery or cesarean section, followed by 10%
dextrose solution at a rate needed to keep the
-glucose within normal limits.³ Some practitioners
prefer insulin withheld on the morning of an
elective cesarean section if the patient should
awaken with acceptable glucose levels. Therefore,
no glucose is given until after the cesarean section
when ½ to ¼ of the pre-pregnancy dose of insulin
can be given.⁴ ⁷

If insulin is given intravenously an infusion
of dextrose in water and close monitoring of glu-
cose levels are imperative. For example, if the
patient presents in the operating room with a
solution of dextrose 5% and 10 units of regular insu-
lin and the glucose falls to less than 70 mg/dl,
then one should start a solution with 5 units
regular insulin and dextrose 5%. If the glucose
rises above 100 mg/dl, one should start a solution
of 15 units regular insulin and dextrose.

Discussion and conclusions

The maintenance of euglycemia during
diabetes in pregnancy is considered paramount to
improve the prognosis of the fetus. Keeping in
mind that the mean glucose in a normal pregnancy
is about 90 mg/dl, we should consider this level
to be our goal.

Two controversial areas that deserve attention
are these. First, there is basically no difference
between an epidural and general anesthesia. There
is however, a study which indicates that infants
of a diabetic mother have a slightly lower pH if
delivered by epidural. It should be noted that this
report is still not definitive at this stage. Also
narcotic premedications are best withheld, because
they tend to interfere with the respiratory assess-
ment of the newborn.

Second, what of adding albumin to an infusion
of dextrose and insulin to prevent the insulin
from adhering to the bag wall? Simply stated, if 10
units of insulin are in the bag and only 6 units
are actually infused, what difference does it make
if our primary clinical objective of managing
euglycemia is met?

In conclusion, the greatest danger to the neo-
ate is a rapid and sudden rise in glucose levels
just prior to delivery. The fetus of a diabetic
mother will produce marked amounts of insulin,
more so than the normal fetus. When delivered,
this neonate will be susceptible to hypoglycemia;
if undetected, such hypoglycemia will lead to
seizures and brain damage.

Therefore, whatever the protocol used during
labor and delivery, prevention of hyperglycemia
in the mother will prevent unnecessary hypo-
glycemia in the neonate. It should be noted that
despite the most diligent care, the end result is
not always favorable; the perinatal mortality rate
is still higher for infants born of diabetic mothers
than in the general population as a whole.

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