# CONTINUOUS SUBCUTANEOUS INSULIN INFUSION

## Improved blood glucose in pregnant diabetics

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SUMMARY

The effect of continuous subcutaneous insulin infusion (c.s.i.i.) on the control of blood-glucose concentration and outcome of pregnancy was assessed in two pregnant diabetics (class B and class C White classification) who were poorly controlled with conventional insulin therapy.

The insulin pump was carried in a holster and enabled the patients to ambulate freely. The patients were able to refill the syringe, to augment the infusion rate at mealtime and to change the implantation site of the needle weekly, and thus, were able to leave the hospital. Daily glucose profiles were assessed 1-3 times a week, and the infusion rate was readjusted accordingly.

Twenty-four hours glucose profiles were obtained from both patients during inpatient conventional insulin regimens, and then, during c.s.i.i. which was maintained for 41 and 145 days, respectively. Mean 24 hours glucose concentrations were reduced from 156 to 113 mg/100 ml, mean fasting glucose from 152 to 106 mg/100 ml, and mean diurnal variation (maximal excursion) from 75 to 65 mg/100 ml.

The favourable results achieved with the c.s.i.i. enabled both patients to reach the 38th week of gestation and to deliver healthy non-macrosomic infants, who had uneventful and morbid-free neonatal periods.

Since the c.s.i.i. supplies insulin in a more physiological manner than twice daily regimens, better control of blood sugar and body fuel metabolism may be achieved.

By extending the therapy to the early stages of pregnancy, or if possible to pre-conceptional period, reduced perinatal mortality and morbidity may be anticipated.

Clin. Exp. Obst. Gyn. - ISSN: 0390-6663
X, nn. 2-3, 1983

INTRODUCTION

Improved control of maternal blood glucose concentration has been shown to be associated with reduced perinatal mortality and morbidity ([1-3]). Conventional twice-daily injection of insulin very often fails to restore glucose levels to normal, and non-physiological diurnal variations are not infrequent.

The introduction of a portable insulin pump which delivers a continuous supply of insulin subcutaneously resulted in an improved control of the diabetes in non-pregnant insulin dependent patients ([4, 5]), and in pregnant diabetics treated so during the third trimester of pregnancy ([6]).

Some pregnant diabetics are very difficult to control with conventional insulin treatment. Hypo and hyperglicemia jeopardize both the mother and her fetus.

It seems particularly appropriate, therefore, to consider this method of insulin administration especially in such patients.

PATIENTS AND METHODS

Clinical data of the two patients studied are presented in table 1. Both were referred to treatment with continuous subcutaneous insulin infusion (c.s.i.i.) after strict diet and conventional twice daily insulin regimen have failed to achieve good control of blood glucose.

A Pye Dynamic MS 16 syringe driver (weight 227 g, size 16.5 cm × 8 cm) was used for insulin infusion (fig. 1). This was carried in a holster (fig. 2) and allowed the patients to be freely ambulant. The rate of infusion was easily altered by a screw adjustment. The disposable syringe was connected to a gauge 25 needle sited subcutaneously in the upper arm, chest or abdomen and held in place with a tape. Patients were taught to refill the syringe, to change the infusion rate over mealtime and to change needle implantation site every week.

A basal infusion rate was delivered to the patients, which was augmented over mealtime for one hour, starting 30 minutes before each main meal.

RESULTS

The portable insulin pump used in this study proved to be practical and reliable. Neither the batteries nor the pump failed.

Table 1. — *Clinical data of the patients.*

| Patient | R. S. | H. H. |
|---|---|---|
| Age | 31 | 27 |
| Outcome of previous pregnancies | Female 5000 g, male 4500 g | — |
| White's classification | B | C |
| Duration of c.s.i.i. treatment | 41 days | 145 days |
| Gestational age at delivery | 38 weeks | $38^{+3}$ weeks |
| Outcome of pregnancy | Induced labor, spontaneous delivery, female 3700 g, Apgar score 10/10 | Spontaneous labor and delivery, female 3050 g, Apgar score 9/10 |
| Neonatal morbidity | None | None |

The patients were able to alter infusion rate before and after meals and recharge the syringe with insulin without difficulty. The patients were freely ambulant, and after good control of the diabetes was obtained, were able to leave the hospital

The initial basal infusion rate was 1 u/h and the augmented dose 9 u/h. This dose was then readjusted, in order to achieve fasting glucose concentrations of about 90 mg/100 ml, and postprandial glucose under 140 mg/100 ml.

Treatment with the c.s.i.i. was started in the first patient (R.S.), when she was in the 32nd week of gestation, and in the second patient (H.H.) when she was in the 16th week of gestation. Both patients have failed to respond favourably to inpatient strict dietary control and twice daily insulin administration. Within 3-5 days glucose concentration in both patients were within the desired limits, despite a 50% reduction in the daily insulin requirements.

Table 2 shows the control of blood glucose concentration on intermittent insulin regimens and on continuous infusion. The mean 24 hour blood glucose concentration fell from 152 mg/100 ml and 160 mg/

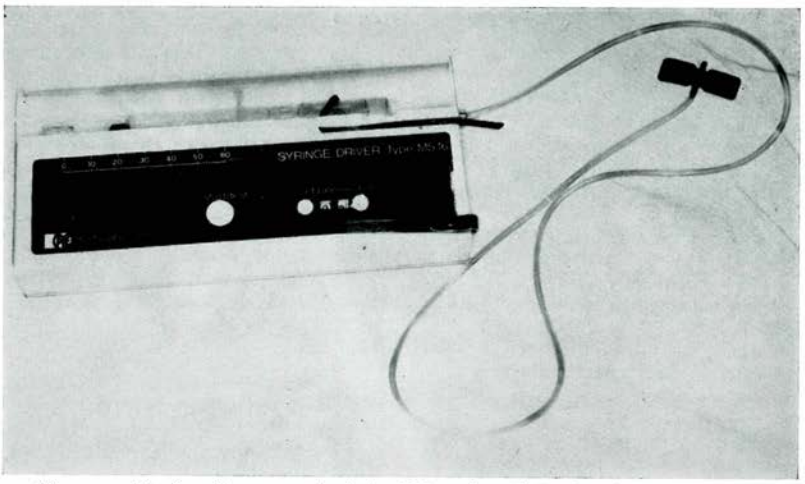


Fig. 1. — The portable insulin pump (weight 227 g, size 16.5×8 cm).

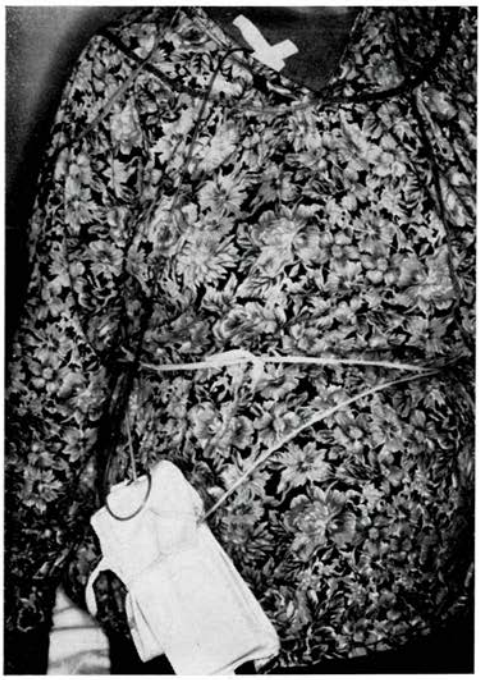

Fig. 2. — The insulin pump is being carried i n a holster. (The holster may be carried under the clothes).

100 ml to 118 mg/100 ml and 108 mg/100 ml, respectively. Fasting glucose concentrations were reduced from 150 mg/100 ml and 148 mg/100 ml to 110 mg/100 ml and 102 mg/100 ml, respectively. There were also reduced diurnal variations of blood glucose concentrations as shown by the lower maximal excursions which fell from 84 mg/100 ml and 66 mg/100 ml to 72 mg/100 ml and 58 mg/100 ml, respectively.

The good control of the diabetes achieved with the c.s.i.i. coupled with reassuring test of fetal well-being enabled both patients to proceed with pregnancy through the 38th week and to deliver healthy and non-macrosomic babies. Neither infants suffered from hypoglycemia or any of the other symptoms frequently seen in newborns of diabetic mothers.

## DISCUSSION

Conventional insulin treatment, as aggressive as it may be, often fails to restore plasma-glucose levels to normal. In addition, it has been shown that even under optimal conditions such therapy cannot restore body-fuel metabolism to normal ([7, 8]). Protein, lipid and carbohydrate metabolic dearrangements may be a contributory factor to the increased perinatal mortality and morbidity in diabetic pregnancies. Karlsson *et al.* ([1]) have presented evidence that mean daily blood glucose concentrations under 100 mg/100 ml during the third trimester in pregnant diabetics are associated with a significant improvement in perinatal outcome. There is also some evidence that optimal control of the diabetes at the time of conception and during the first trimester of pregnancy may reduce the rate of congenital malformations.

Recently, it has been shown that with the use of c.s.i.i. in non-pregnant diabetic patients mean 24 hour plasma-glucose was not significantly different from that in non diabetics ([4]). Not only blood glucose but also the major carbohydrate metabolites (lactate, pyruvate, ketone body, 3-hydroxybutyrate) plasma cholesterol, triglycerides, free fatty acids and branched-chain aminoacids which were abnormally high during conventional insulin treatment approached normal levels during c.s.i.i. ([4, 5]).

Encouraging results were also achieved by Potter *et al.* ([6]) in pregnant diabetics treated with the c.s.i.i. during the third trimester of pregnancy. Potter's patients

Table 2. — *Control of blood glucose (mg/100 ml) during c.s.i.i. (top figures) as compared to intermittent insulin injection (bottom figures).*

| Case | Mean 24 hour glucose | Mean fasting glucose | Maximum excursion |
|---|---|---|---|
| R. S. | *118* | *110* | *72* |
| | 152 | 156 | 84 |
| H. H. | *108* | *102* | *58* |
| | 160 | 148 | 66 |

were under good control with conventional insulin treatment and that explains why only slight improvement in the diabetes control was achieved. The potential of the c.s.i.i. in the treatment of pregnant diabetics becomes more prominent in the present study, since both patients were selected for treatment with the c.s.i.i. because they were poorly controlled with intermittent insulin injections.

The objective of this study was to assess the value of the c.s.i.i. in pregnant diabetic who are difficult to control with intermittent insulin administration. The results are encouraging. More experience with a larger group of patients is required in order to draw final conclusions as to the value and practicability of this method. It seems, however, obvious that the c.s.i.i. supplies insulin in a more physiological manner than the intermittent injections of insulin.

It is postulated that by extending the treatment with the c.s.i.i. to the first trimester of pregnancy, or if possible, prior to conception, many of the metabolic dearrangements associated with diabetes may be eliminated, and improved fetal outcome may be anticipated.

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