

Case Report

Fluctuation of blood glucose levels in an infant with an ileostomy on continuous glucose monitoring: A case report

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Abstract. Infants with an ileostomy can be at high risk of hypoglycemia because of inadequate nutritional intake; however, there are no reports investigating blood glucose (BG) in infants with ileostomy. We experienced a case of an extremely low birth weight infant who was born at 24 wk of gestation and weighted 623 g. He received an ileostomy because of an intestinal perforation. After the ileostomy, he had recurrent hypoglycemia. Continuous glucose monitoring showed fluctuation of BG levels (postprandial BG elevations and subsequent declines) and non-fasting hypoglycemia, which were undetectable with intermittent fasting BG measurement. The fluctuation of BG levels and non-fasting hypoglycemia improved after closure of the ileostomy. Patients with ileostomy may present with hypoglycemia that is undetectable with intermittent fasting BG measurement. In this case, continuous glucose monitoring was very useful for detecting fluctuation of BG levels and hypoglycemic episodes. Therefore, we recommend that continuous glucose monitoring be performed in infants with an ileostomy to confirm whether they have hypoglycemia or a fluctuation in BG levels. Further studies on the postprandial dynamics of various hormones in infants with ileostomy are required.

Key words: blood glucose fluctuation, hypoglycemia, continuous glucose monitoring, ileostomy, infant

Introduction

Neonatal hypoglycemia is a common and treatable risk factor for neurologic impairment

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in children (1). Preterm infants, low birth weight infants, and small for gestational age infants are at a high risk of neonatal hypoglycemia because of their limited glycogen storage and increased energy demand (2–4). Infants who receive an ileostomy can also be at high risk of hypoglycemia because of inadequate nutritional intake, although there are no reports investigating blood glucose (BG) in infants after ileostomy.

Normally, BG concentrations are measured intermittently; therefore, episodes of hypoglycemia may be undetectable and their duration and severity cannot be assessed (5). Continuous glucose monitoring (CGM), which

can monitor interstitial glucose concentrations continuously, has been developed for the management of diabetes mellitus. Several studies reported that CGM was useful, safe, and reliable in infants, including very low birth weight infants (5–7). CGM has been found to help detect episodes of hypoglycemia and fluctuations of BG levels that are undetectable with intermittent BG measurement (5, 8, 9). Mizumoto *et al.* reported that in some preterm infants receiving intermittent tube feeding, a large fluctuation of BG levels was shown on CGM that was unrecognized on routine blood screening (6).

No reports have investigated fluctuation of BG levels using CGM after ileostomy. We present a case of an extremely low birth weight infant who showed non-fasting hypoglycemia on CGM after ileostomy, and improvement after closure of the ileostomy.

Case Presentation

A male infant was born at 24 wk and 6 d of gestation by cesarean section because his mother had uncontrollable pregnancy-induced hypertension. His body weight was 623 g and Apgar scores were 1 and 7 at 1 and 5 min, respectively. He was the second child of non-consanguineous Mongolian parents. Neonatal resuscitation and intubation were performed in the delivery room, and the patient was admitted to the neonatal intensive care unit. He had been treated with surfactant for respiratory distress syndrome, intravenous indomethacin for patent ductus arteriosus, and intravenous hydrocortisone for bronchopulmonary dysplasia during the neonatal period. On day 48 (body weight 1,049 g), intestinal perforation due to incarcerated right inguinal hernia occurred, and he received tube ileostomy and inguinal hernia repair. After the operation, enteral nutrition (using a nasogastric tube) was increased gradually and reached sufficient quantity on day 62 (20 mL/kg every 3 h; 160 mL/kg/d). The

ileostomy tube was extracted on day 70, and the ileostomy closed spontaneously. After the operation, his serum direct bilirubin level rose gradually, and reached 7.1 mg/dL on day 106.

On day 127 (body weight 2,480 g), ileocecal perforation due to milk-curd syndrome occurred, and the patient underwent another ileostomy (about 10 cm proximal from the terminal ileum) with resection of ileocecum and terminal ileum (10-cm length). After the operation, enteral nutrition was increased gradually and reached sufficient quantity on day 140 (22 mL/kg every 3 h; 176 mL/kg/d). However, he suffered from occasional hypoglycemia and growth retardation (increase of 50–80 g per wk), despite enteral nutrition being increased to 200 mL/kg/d. His cholestasis improved gradually, and serum direct bilirubin level was 2.0 mg/dL on day 205. After this improvement in cholestasis, his growth retardation also improved gradually (increase of 150–200 g per wk), but there was no improvement in hypoglycemia. When the patient received very slow injection feeding for 2.5 h every 3 h, no fasting hypoglycemia was detected. However, when we tried to shorten the feeding injection time to less than 2 h, hypoglycemic episodes recurred according to intermittent BG measurements (we measured fasting BG levels 3–4 times a d). Therefore, the patient required very slow injection feeding. We diagnosed hyperinsulinemic hypoglycemia using critical samples, which were obtained when BG was 36 mg/dL, serum insulin level was 1.3 μ U/mL, free fatty acid level was 0.16 mmol/L, and β -hydroxybutyrate level was 0.025 mmol/L. We suspected that when he was administered rapid feeding injection, his BG levels were prone to fluctuate and hypoglycemic episodes might occur, which are undetectable with intermittent BG measurement. Therefore, we planned to perform CGM in an attempt to shorten the feeding injection time.

We used iPro2[®] for CGM with an Enlite[®] sensor (Medtronic Japan, Tokyo, Japan). The sensor was placed manually onto the subcutaneous tissue ventrolateral to the thigh.

The sensor is a platinum electrode coated with glucose oxidase that converts interstitial glucose concentration into an electrical signal. CGM was able to read out the glucose concentrations only retrospectively (after removal of the sensor and analysis of the data) and not in real time; therefore, we were unable to assess and provide intervention for hypoglycemic episodes in real time. When we analyzed the CGM sensor data, it was necessary to enter the BG concentrations measured by capillary blood to calibrate the CGM sensor data. Therefore, during CGM, we had to measure capillary BG at least four times a day. The glucose concentration values were expressed in mg/dL in a range between 40 mg/dL (2.2 mmol/L) and 400 mg/dL (22.2 mmol/L). We used StatStrip Xpress900[®] (Nova Biomedical, Waltham, MA, USA) for measurement of BG in samples obtained by capillary heel prick lancing. StatStrip uses a method that can correct for background noise by measuring interference such as hematocrit, oxygen, and electrochemical substances (acetaminophen and ascorbic acid), and therefore can measure BG accurately in infants (10). In addition, StatStrip can measure BG accurately at lower levels (10). The use of this CGM device was approved by the Institutional Review Board. We obtained written informed consent from the patient's parents.

We performed CGM for 72 hours from days 217 to 220 (Fig. 1). During CGM, we tried to shorten the feeding injection time from 2.5 hours to 1.5 h. CGM showed a fluctuation in BG levels and non-fasting hypoglycemic episodes, which were undetectable with intermittent fasting BG measurement. We considered that closure of the ileostomy could contribute to improvement of hypoglycemia, and performed closure on day 237 (body weight 4,156 g). After the operation, no hypoglycemic episodes were observed with intermittent BG measurements. We were able to gradually shorten the feeding injection time. On day 245, the patient was weaned from tube feeding and fed 20 mL/kg breast milk every 3 h orally (160 mL/kg/d). To investigate the

fluctuation of BG levels, we performed CGM again from days 246 to 249 (Fig. 2). CGM showed that the fluctuation and hypoglycemic episodes had improved. The patient was discharged from the hospital on day 267 (body weight 4,714 g).

Discussion

To the best of our knowledge, this is the first report to investigate fluctuation of BG levels before and after closure of ileostomy in an infant. Our case showed non-fasting hypoglycemia on CGM before closure of the ileostomy. The non-fasting hypoglycemia improved after closure of the ileostomy.

The cause of the fluctuating BG levels and non-fasting hypoglycemia in our patient was unclear, as was the mechanism of improvement of non-fasting hypoglycemia after closure of the ileostomy. Loss of nutrients from a stoma can represent a risk for hypoglycemia. Therefore, improved nutritional intake could lead to improvement in the fluctuation of BG levels and non-fasting hypoglycemia in our patient. Body growth, intestinal maturity, or change of method and amount of feeding could also contribute to changes in the glycemic pattern. If we had performed CGM before ileostomy, we could have obtained important information. However, as we did not detect hypoglycemia by intermittent BG measurements we did not perform CGM prior to ileostomy. In addition to these factors, we speculate that inadequate secretion of gut hormones such as incretin may be related to fluctuation of BG levels in our patient. Robertson *et al.* reported that the pattern of incretin secretion in adult patients with ileostomy was different from that in healthy controls (11). However, we could not measure the concentrations of insulin and gut hormones because of the problematic amount of blood sampling. By employing "real-time CGM", which can read out the glucose concentrations in real time and alert us of hypoglycemia and hyperglycemia, we are able to measure the concentrations of various

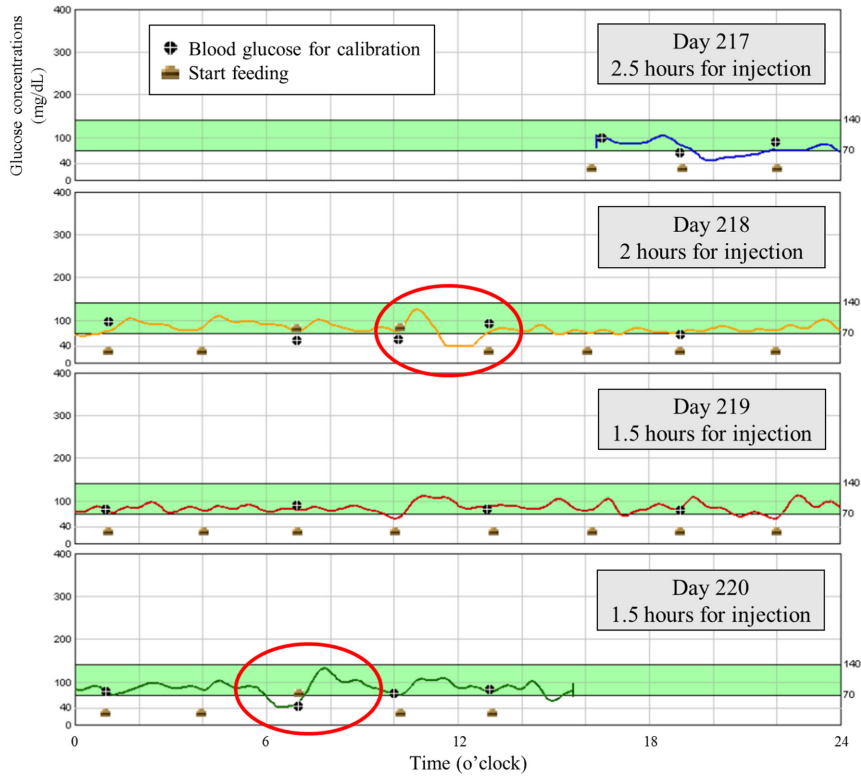


Fig. 1. Continuous glucose monitoring before closure of ileostomy on days 217–220.

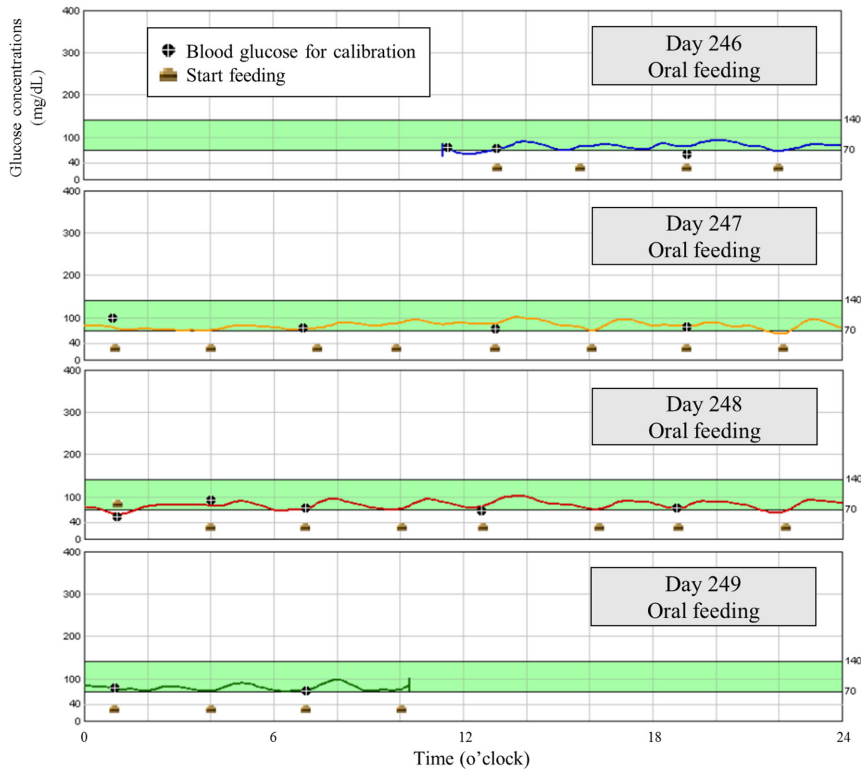


Fig. 2. Continuous glucose monitoring after closure of ileostomy on days 246–249.

hormones at appropriate time points and reduce the extent of blood sampling. Further studies on the postprandial dynamics of various hormones in infants with ileostomy are required.

In conclusion, we experienced a case of an extremely low birth weight infant who showed fluctuation of BG levels and non-fasting hypoglycemia on CGM after ileostomy. Patients with ileostomy may present with non-fasting hypoglycemia, which is undetectable by intermittent fasting BG measurement. CGM was very useful for detecting fluctuation of BG levels and hypoglycemic episodes. Therefore, we consider that CGM should be performed for infants with ileostomy to verify whether they have hypoglycemia or a fluctuating BG level.

Conflict of Interest: The authors have no conflict of interest or financial assistance to disclose.

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