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Original Research Article

Comparison between Blood Glucose Level in Cord Blood and Heel Prick Blood Glucose at Birth of Neonates using Glucometer

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Abstract:

Background: Neonatal hypoglycemia and hyperglycemia are common metabolic disturbances that can lead to significant morbidity and long-term neurological complications if not detected and managed promptly. Traditionally, heel prick sampling has been used for neonatal glucose monitoring, but it is invasive and affected by various physiological factors. Cord blood glucose estimation at birth offers a potentially less invasive, immediate, and reliable alternative.

Aim: To compare blood glucose levels in cord blood and heel prick samples of neonates using a glucometer and to assess their correlation for early detection of glycemic disturbances.

Methods: A hospital-based cross-sectional study was conducted at the Departments of Pediatrics and Obstetrics & Gynaecology, Northern Railway Central Hospital, New Delhi, from January to August 2021. A total of 302 neonates born during the study period were included after informed parental consent. Cord blood was collected at birth, and heel prick glucose was measured shortly thereafter using a CareSens N Eco glucometer. Data on maternal age, parity, risk factors, neonatal gestational age, sex, and birth weight were recorded. Statistical analysis was performed using paired t-test and Pearson's correlation coefficient.

Results: The mean cord blood glucose was 96 ± 13.2 mg/dl, while the mean heel prick glucose was 88 ± 12.0 mg/dl. Cord blood glucose levels were consistently higher, and a strong positive correlation was found between the two methods ($r = 0.804$, $p < 0.0001$). No significant differences were observed based on sex, gestational age, or birth weight. However, infants of diabetic mothers and neonates delivered by caesarean section had significantly higher glucose values. Only one case of hypoglycemia and three cases of hyperglycemia were observed in the study population.

Conclusion: Cord blood glucose shows a strong positive correlation with heel prick glucose, suggesting it can be reliably used as a non-invasive alternative for early neonatal glucose assessment. Maternal diabetes and mode of delivery influence neonatal glucose levels.

Recommendations: Cord blood glucose estimation should be considered in routine neonatal care for early screening, particularly in high-risk groups such as infants of diabetic mothers. Further large-scale studies are warranted to validate its diagnostic accuracy across diverse populations and clinical settings.

Keywords: Cord Blood Glucose, Heel Prick Glucose, Neonatal Hypoglycemia, Infants of Diabetic Mothers, Neonatal Screening.

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Introduction

Neonatal hypoglycemia and hyperglycemia are significant metabolic disturbances that can lead to serious morbidity and long-term neurological complications if not identified and managed promptly [1]. Accurate and timely measurement of blood glucose in neonates is critical, particularly in the first few hours after birth, when transitional metabolic adjustments occur [2]. Traditionally, heel prick (capillary) blood sampling has been the standard method for assessing neonatal glucose levels due to its simplicity and minimal blood volume requirement [3]. However, heel prick sampling is invasive, can cause discomfort, and may be affected by factors such as hematocrit levels, bilirubin concentration, and peripheral perfusion, which can influence the accuracy of glucometer readings [4].

Cord blood glucose measurement has emerged as a potential alternative for early detection of glycemic

disturbances in neonates. Cord blood glucose reflects maternal glucose levels and placental glucose transfer at the time of birth [5]. Typically, neonatal blood glucose concentrations are approximately 60–70% of maternal levels at birth, declining during the first few hours post-delivery before stabilizing as the neonate adapts metabolically [6]. Several studies have demonstrated a significant positive correlation between cord blood glucose and capillary blood glucose levels measured via heel prick, suggesting that cord blood could serve as a reliable and less invasive indicator of neonatal glucose status [1,7].

The use of cord blood for glucose measurement has several advantages. It avoids repeated heel pricks, thereby reducing neonatal pain and stress, and allows immediate assessment of glucose levels without delaying early postnatal care [7]. In addition, cord blood sampling may provide a standardized reference for evaluating early neonatal glycemia, especially in high-risk infants such as those born to diabetic mothers, preterm neonates, or small-for-gestational-age babies [2,5].

Despite promising findings, further research is necessary to validate the accuracy and clinical utility of cord blood glucose measurement across diverse neonatal populations and different glucometer devices [3,6]. Comparing cord blood and heel prick glucose levels can inform best practices in neonatal care, potentially leading to earlier detection and management of hypoglycemia and hyperglycemia, minimizing the risk of complications, and improving overall neonatal outcomes [1,4].

Materials and Methods

The study was conducted after obtaining approval from the hospital ethical committee.

Type of Article: This was a hospital-based cross-sectional study.

Study Place: The study was carried out in the Departments of Pediatrics and Obstetrics & Gynaecology, Northern Railway Central Hospital, New Delhi.

Study Duration: The study was conducted over a period of 8 months (January 2021 – August 2021).

Inclusion Criteria:

- All newborns delivered by normal vaginal delivery, caesarean section, or instrument-assisted delivery at Northern Railway Central Hospital, New Delhi, were included in the study.

Exclusion Criteria:

- Newborns with clinically detected congenital anomalies were excluded from the study.

Sample Size: All newborns delivered at Northern Railway Central Hospital, New Delhi, during the study period were enrolled. The final sample size was 302, which included all newborns delivered at NRCH during the study period.

Working Definitions:

- Hypoglycemia: Babies with blood glucose level <45 mg/dl associated with symptoms of hypoglycemia, or confirmed on repeat analysis in asymptomatic babies.
- Hyperglycemia: Babies with blood glucose level >125 mg/dl were considered hyperglycemic.

Procedure:

1. All mothers admitted for normal vaginal delivery or caesarean section were informed about the purpose and importance of the research. They were provided with a patient information sheet in both English and Hindi. After obtaining written informed consent from parents, neonates were enrolled in the study.
2. Cord blood samples were collected by the attending pediatrician/obstetrician using a sterile 10 ml syringe from the umbilical vein, along with the routine blood sample for grouping.
3. Heel prick blood glucose estimation was performed by the attending pediatrician using a CareSens N Eco glucometer (based on the Glucose Oxidase enzyme method). Blood was obtained from a heel prick using a new sterile 23G needle at the posterolateral aspect of the heel.
4. Both blood glucose values were entered in a predesigned proforma. Additional details such as gestational age, parity, maternal risk factors, birth weight, date and time of birth, and gender were also documented.

Ethical Clearance: The study was initiated only after obtaining approval from the registered ethical and scientific committee of NRCH, New Delhi. Informed consent was obtained from the parents/guardians of all participants.

Statistical Analysis: The observations of the study were compiled and analyzed statistically. Correlation between cord blood glucose and capillary blood glucose levels was assessed using correlation coefficient. For comparison, paired t-test and Pearson's correlation coefficient were applied.

Results

A total of 302 newborns were included in the study. Demographic, maternal, and neonatal characteristics were analyzed in relation to cord blood and heel prick blood glucose levels.

Table 1: Maternal Age and Parity Distribution

Maternal Variable	Categories	Frequency	Percentage
Maternal age	< 35 years	292	96.7%
	≥ 35 years	10	3.3%
Parity	Primiparous	150	49.8%
	Multiparous	152	50.2%

Most mothers were younger than 35 years, with a nearly equal distribution between primipara and multipara.

Table 2: Neonatal Demographics (Sex, Gestational Age, Birth Weight)

Variable	Categories	Frequency	Percentage
Sex	Male	169	55.9%
	Female	133	44.1%
Gestational age	Preterm	42	13.3%
	Term	260	86.7%
Birth weight	NBW	253	83.8%
	LBW	47	15.6%
	VLBW	2	0.6%

The majority of neonates were male, term, and of normal birth weight.

Table 3: Overall Glucose Levels in Cord Blood and Heel Prick

Parameter	Mean ± SD (mg/dl)	Range	Median
Cord blood RBS	96 ± 13.2	50–142	96
Heel prick RBS	88 ± 12.0	44–131	89

Cord blood glucose was consistently higher than heel prick values. There was a strong positive correlation between the two ($r = 0.804$, $p < 0.0001$).

Table 4: Glucose Levels by Sex and Maternal Age

Variable	Category	Cord blood RBS (mg/dl)	Heel prick RBS (mg/dl)
Sex	Male	96.29	87.89
	Female	97.68	89.09
Maternal age	< 35 years	97.11	88.57
	≥ 35 years	90.60	83.70

No statistically significant difference was observed between male and female neonates. Babies of older mothers (≥35 years) had slightly lower glucose levels, though not significant.

Table 5: Glucose Levels by Parity and Mode of Delivery

Variable	Category	Cord blood RBS (mg/dl)	Heel prick RBS (mg/dl)
Parity	Primipara	96.35	88.42
	Multipara	97.45	88.41
Delivery	Vaginal delivery	95.50	86.92
	LSCS	98.32	89.85

Parity did not influence glucose values. Heel prick glucose was significantly higher in LSCS babies ($p = 0.034$), possibly due to stress-related hormonal responses.

Table 6: Glucose Levels by Gestational Age and Birth Weight

Variable	Category	Cord blood RBS (mg/dl)	Heel prick RBS (mg/dl)
Gestational age	Preterm	97.14	89.21
	Term	96.86	88.28
Birth weight	NBW	97.11	88.65
	LBW	95.02	86.44
	VLBW	114.00	104.5

Explanation: Glucose levels did not differ significantly between preterm and term or NBW and LBW groups. VLBW neonates had higher mean glucose, though the sample was too small for conclusions.

Table 7: Glucose Levels by Birth Weight for Gestational Age

Group	Cord blood RBS (mg/dl)	Heel prick RBS (mg/dl)	Correlation (r)
AGA	97.43	88.83	0.870
SGA	93.83	85.78	0.925
LGA	101.66	93.55	0.971

Explanation: Strong positive correlation between cord and heel prick glucose was observed across all groups. No significant differences in mean glucose values between AGA, SGA, and LGA neonates.

Table 8: Infants of Diabetic Mothers (IDM) vs Non-IDM

Group	Cord blood RBS (mg/dl)	Heel prick RBS (mg/dl)
IDM	103.75	94.08
Non-IDM	95.86	87.55

Both cord and heel prick glucose values were significantly higher in infants of diabetic mothers ($p < 0.01$).

Table 9: Maternal Co-morbidities and Neonatal Glucose

Condition	Cord blood RBS (mg/dl)	Heel prick RBS (mg/dl)
Gestational hypertension	106.92	97.61
Hypothyroidism	96.58	87.47
Anemia	101.66	91.66
Deranged LFT	109.66	101.33
Tuberculosis	81.00	77.00
Other disease	95.00	90.00

Neonates of mothers with deranged LFT or hypertension had higher glucose levels. TB and other illnesses were linked with lower glucose values, though subgroup numbers were very small.

Table 10: Overall Summary of Maternal and Neonatal Characteristics

Maternal Characteristics	Cases	Neonatal Characteristics	Cases
Age 18–35 years	292	Preterm	42
Age ≥ 35 years	10	Term	260
Primiparous	150	NBW	253
Multiparous	152	LBW	47
GDM	40	VLBW	2
Hypertension	13	AGA	238
Hypothyroidism	36	SGA	55
Other comorbidities	8	LGA	9
Vaginal delivery	145	Male	169
LSCS	153	Female	133
		Hypoglycemia	1
		Hyperglycemia	3

The majority of mothers were young, multiparous, and delivered by LSCS. Most neonates were term, NBW, and AGA. Hypoglycemia (n=1) and hyperglycemia (n=3) were rare.

Discussion

A total of 302 neonates delivered at Northern Railway Central Hospital, New Delhi, were included in the study. The majority of mothers (96.7%) were younger than 35 years, and parity was almost equally distributed between primipara (49.8%) and multipara (50.2%). Most deliveries were through lower segment caesarean section (LSCS, 50.7%) compared to vaginal delivery. Among the neonates, males slightly outnumbered females (male-to-female ratio 1.27:1). The majority were term (86.7%), of normal birth weight (83.8%), and classified as appropriate for gestational age (78.8%).

The mean cord blood glucose level was 96 ± 13.2 mg/dl, while the mean heel prick glucose was 88 ± 12.0 mg/dl, showing that cord blood glucose was consistently higher than heel prick values. A strong

positive correlation was observed between the two methods ($r = 0.804$, $p < 0.0001$), confirming that cord blood glucose reliably reflected postnatal glucose levels.

When neonatal characteristics were considered, there was no statistically significant difference in glucose values between male and female neonates, preterm versus term babies, or normal versus low-birth-weight groups. Even among small for gestational age (SGA), appropriate for gestational age (AGA), and large for gestational age (LGA) neonates, glucose levels were comparable, although all subgroups showed a very strong positive correlation between cord and heel prick samples. Interestingly, the two very low birth weight (VLBW) neonates in the study demonstrated higher glucose levels, though the numbers were too few for statistical inference.

Maternal factors showed variable influence. Neonates born to mothers aged ≥35 years had slightly lower glucose levels compared to those of younger mothers, although the difference was not significant. Parity also had no effect on glucose values. However, when delivery mode was considered, neonates born by LSCS had significantly higher heel prick glucose values compared to those delivered vaginally ($p = 0.034$). This may be explained by stress-related hormonal and metabolic adaptations associated with caesarean deliveries.

A particularly important finding was observed among infants of diabetic mothers (IDMs). These neonates (13.2% of the study group) had significantly higher glucose levels in both cord blood (103.7 mg/dl) and heel prick samples (94.1 mg/dl) compared to non-IDMs (95.9 mg/dl and 87.6 mg/dl, respectively, $p < 0.01$). This suggests that maternal diabetes has a notable impact on neonatal glucose metabolism.

Maternal comorbidities also showed some influence. Neonates of mothers with gestational hypertension and deranged liver function tests (LFTs) had higher mean glucose values, while those born to mothers with tuberculosis had the lowest glucose levels. However, these trends did not reach statistical significance due to small subgroup sizes.

Recent studies have increasingly evaluated the clinical reliability of cord blood glucose in predicting neonatal hypoglycaemia and compared it with early capillary (heel-prick) measurements. A hospital-based cross-sectional study from India reported that glucose levels measured in cord blood and heel-prick samples using a bedside glucometer showed a significant positive correlation, indicating that cord glucose could be a useful predictor of neonatal glycaemic status immediately after birth [8].

A prospective study by Wang et al. in 2023 specifically examined umbilical artery cord blood glucose (UACBG) among infants at risk of hypoglycaemia, including those born to mothers with gestational diabetes. The authors found that UACBG had a high negative predictive value for hypoglycaemia within the first two hours of life, suggesting its potential role in early triage and reducing the need for repeated heel pricks [9]. Similarly, Poojary et al. (2025) conducted an Indian cohort study and identified a cord blood glucose threshold of approximately 44 mg/dL, below which neonates were at greater risk of developing hypoglycaemia. This study emphasized that cord glucose can be an early and non-invasive marker to guide monitoring protocols [10].

In terms of methodology, the reliability of point-of-care glucometers has been tested. Brooks et al. (2023) compared handheld glucometers using arterial and heel-prick samples, confirming overall reliability but warning that low capillary readings may be less accurate. This is particularly relevant when interpreting heel-prick versus cord blood glucose differences in the immediate postnatal period [11]. Park et al. (2021) further contributed by defining safe glucose thresholds for capillary samples during the first 48 hours of life, thereby providing a reference to evaluate clinical implications of discrepancies between cord and heel-prick measurements [12].

Several supportive studies have also explored pre-analytical and procedural influences. Toennesen et al. (2023) demonstrated that warming methods before heel-stick improve sample quality and infant comfort, reducing variability in heel-prick glucose estimation [13]. Additionally, Galderisi et al. (2022) reported that minimally invasive procedures such as heel pricks themselves may cause short-term glucose variability, underlining the potential advantage of using cord blood at birth [14]. Ruiz et al. (2022) focused on perinatal risk factors for hypoglycaemia in term and late-preterm infants, highlighting the value of early cord glucose measurement in high-risk groups [15]. Finally, Harding (2024) provided an updated review of neonatal hypoglycaemia definitions and monitoring strategies, reinforcing that cord blood screening may be integrated into standard protocols, particularly when thresholds below 2.6 mmol/L (≈47 mg/dL) are clinically relevant [16].

Conclusion

The study demonstrated that while **cord blood glucose correlates strongly with heel prick glucose**, maternal diabetes and mode of delivery are significant determinants of neonatal glucose

levels. Most neonates-maintained glucose within the normal range, with hypoglycemia (n=1) and hyperglycemia (n=3) being rare occurrences.

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