

ORIGINAL RESEARCH

Comparison of transcutaneous bilirubin with serum bilirubin in a tertiary care newborn unit: A cross-sectional study

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ABSTRACT

Background: The purpose of this study was to use the Drager jaundice metre JM-105 to compare transcutaneous bilirubin (TcB) measurement with total serum bilirubin (TSB) in neonates with clinically significant jaundice. **Methods:** A tertiary care hospital carried out a cross-sectional study on 50 jaundiced neonates who needed their serum bilirubin levels to be determined between days two and three of life. **Results:** The transcutaneous bilirubin (TcB), which is tested at the forehead, was 14.1 mg/dL, while the mean total serum bilirubin (TSB) was 14.4 mg/dL. Additionally, the mean difference between TcB and TSB was 0.3 mg/dL. Between TSB and TcB forehead, a positive linear connection was found ($r=0.76$). **Conclusion:** Because of its accuracy, TcB measured at the forehead is a useful non-invasive diagnostic test for screening newborns from South India for hyperbilirubinemia.

Key words: Neonatal jaundice, total serum bilirubin and transcutaneous bilirubin

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INTRODUCTION

One of the most frequent reasons for hospital stay in the first week following delivery is neonatal jaundice. The cause of it is hyperbilirubinemia¹. Nearly 50% of term babies and 80% of preterm neonates have some degree of neonatal hyperbilirubinemia, making it a prevalent issue². Although bilirubin encephalopathy (kernicterus) can result from severe newborn hyperbilirubinemia, the majority of cases are benign. Athetoid cerebral palsy, high-frequency hearing loss, and intellectual incapacity are among the problems that survivors of kernicterus typically face. Kernicterus is linked to a high mortality rate³. Early treatment with phototherapy or exchange blood transfusion, along with adequate serum bilirubin monitoring, can prevent severe neonatal hyperbilirubinemia and its consequences.

According to recent findings, assessing jaundice visually is dangerous and unreliable⁴.

While getting TSB is the most popular method for determining an infant's bilirubin level, drawing blood may be an uncomfortable and time-consuming process. Frequent TSB assessments have also raised concerns in studies, as there is a higher risk of

infection and anaemia, especially in very preterm newborns. Additionally, preterm infants have been shown to experience repetitive procedural pain and stress^{5, 6}. An alternate method for estimating bilirubin levels has been the transcutaneous bilirubinometer, which measures bilirubin levels by photometry. Transcutaneous bilirubinometers are non-invasive, painless, and portable medical instruments. By applying pressure with a probe to the newborn's forehead or sternum, the bilirubin level is determined. It produces an instantaneous outcome, enabling the start of therapy right away and lessening the load on medical professionals. Because transcutaneous bilirubin (TcB) levels and TSB have a strong association, the transcutaneous bilirubinometer is a useful screening tool for TSB in the management of hyperbilirubinemia globally⁷.

Nevertheless, in our nation, only few investigations were conducted with transcutaneous bilirubinometers. In infants with clinically severe jaundice, this study compared the measurement of transcutaneous bilirubin (TcB) with total serum bilirubin (TSB).

AIM: To compare TcB measurement with Total Serum Bilirubin (TSB) in neonates (term as well preterm >35 weeks) with clinically significant jaundice.

OBJECTIVE: To compare TcB levels with Total Serum Bilirubin level (TSB) in neonates (term as well preterm >35 weeks) with clinically significant jaundice admitted in NICU of a tertiary care centre in south India.

MATERIAL AND METHODS

STUDY AREA/PLACE

Department of Paediatrics (NICU) at Dr. Somervell Memorial CSI Medical College Karakonam.

STUDY DESIGN

Cross-sectional study.

STUDY PERIOD

March 2023 to February 2024.

INCLUSION CRITERIA

1. Gestational age of 35 weeks (35 wks.) and above of both the genders.
2. Birth weight (BW) >2000 gram or >2.0 kilograms.
3. >24 hours of age whose parents/guardian who have given consent.
4. Clinical jaundice \geq 24 hours of life.

EXCLUSION CRITERIA

1. Clinical jaundice \leq 24 hours of life.
2. Clinical jaundice after 7 days of life.
3. Babies at high risk of neonatal hyperbilirubinemia.
4. Preterm babies, low birth weight, babies whose mothers have positive antibody screening, babies with positive Coombs test, babies requiring serum TSB sampling within 24 hours of life, already on phototherapy, conjugated hyperbilirubinemia, history of sibling with G6PD deficiency, kernicterus and exchange transfusion.

SAMPLE SIZE

$$n = \frac{\left[\frac{z_{\alpha} + z_{1-\beta}}{2} \right]^2}{\frac{1}{4} \log \left(\frac{1+r}{1-r} \right)} + 3$$

$Z_{\alpha/2} = 1.96$ (Level of significance at 5%).

$Z_{1-\beta} = 0.84$ (power of the test).

$r = 0.75$ (correlation coefficient). $n = 39.89$ $n = 40$. The minimum sample size required for the study was 40 subjects and rounded of to 50.

SAMPLING TECHNIQUES

Consecutive sampling.

STUDY VARIABLES

Transcutaneous bilirubin and serum bilirubin.

NORMAL RANGE

TOTAL BILIRUBIN: 4-8mg/dl.

STUDY TOOLS

Pre-designed pre-tested questionnaire.

STUDY PROCEDURE

Data collection began after getting ethics committee approval. All newborns delivered at Dr. Somervell Memorial CSI Medical College who fulfil the inclusion criteria were considered for the study. After obtaining informed consent, all newborns fulfilling the inclusion criteria were considered for the study after ruling out exclusion criteria. TcB was measured at forehead using TcB meter within 30 minutes of obtaining samples for TSB. TcB and TSB difference was noted.

STATISTICAL ANALYSIS

- The gathered data was coded, then exported to SPSS and placed into a Microsoft Excel work sheet.
- Version 26 of the statistical package for social sciences (SPSS) was used to analyze the data.
- For test of significance paired test was used and a p-value of <0.05 is considered statistically significant.

RESULTS

Table 1 shows the demography of the babies where 48% were males and 52% were females. All the babies were between 36-40 weeks of gestation and the mode of delivery was normal in 62% and 38% underwent lower section caesarean section. The mean birth weight was 2.9 ± 0.4 Kgs with majority of the babies being above 2500 grams. The mean hours after birth to the appearance of neonatal jaundice was 68.6 ± 8.4 hours. In the study all the babies were exclusively breast feed, none required any medications and none had G6PD (glucose- 6- phosphate dehydrogenase).

The mean total bilirubin via transcutaneous method was 14.1 ± 1.3 mg/dl and using venous method the mean was 14.4 ± 1.5 mg/dl as shown in table 2 & figure 2. When both the methods were compared there was no difference ($p = 0.23$) noted between them suggesting transcutaneous method being non-invasive is equivalent to the venous method (laboratory).

In the study the complications are shown in table 3, 82% had neonatal hyperbilirubinemia followed by neonatal hyperbilirubinemia and diabetic mother, 4% each had neonatal hyperbilirubinemia+ patent foramen ovale and neonatal hyperbilirubinemia+ transient tachypnoea of newborn and 2% each were small for gestational age and transient tachypnoea of newborn respectively.

Table 1: Demographic distribution

Demography	Frequency	Percent
Gender		
Male	24	48%
Female	26	52%
Gestational age (weeks)		
35-37	1	2%
37-40	49	98%
Mode of delivery		
Normal	31	62%
LSCS	19	38%
Birth weight		
2000-2500 grams	9	18%
2500-3000 grams	20	40%
>3000 grams	21	42%
Mean birth weight: 2.9± 0.4 Kgs		
Day of life (hrs)		
48 hours	7	14%
72 hours	43	86%
Mean hours:68.6± 8.4 hours		

Table 2: Total bilirubin by transcutaneous and venous method

Total bilirubin	TcB	TSB	p-value
>8 mg/dl	-	-	0.23
>8 mg/dl	50	50	
Mean	14.1± 1.3	14.4± 1.5	

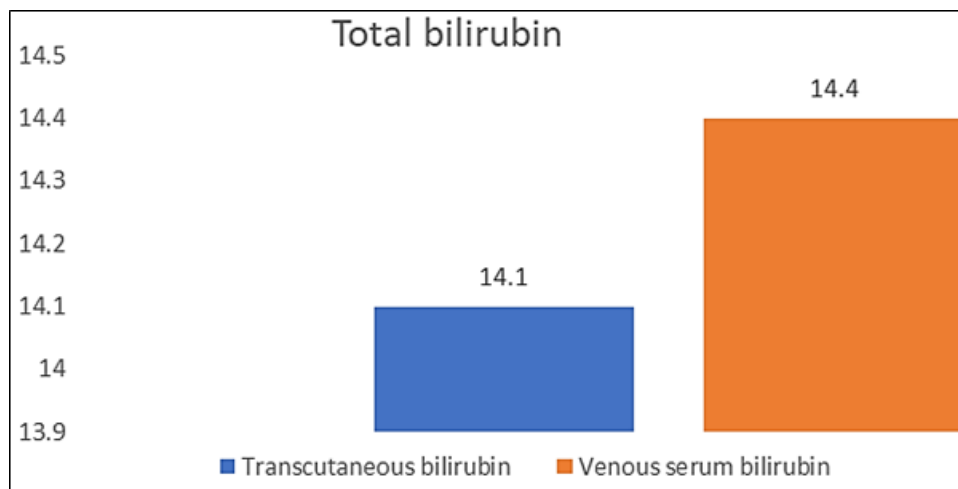


Fig 1: Column chart showing total bilirubin levels

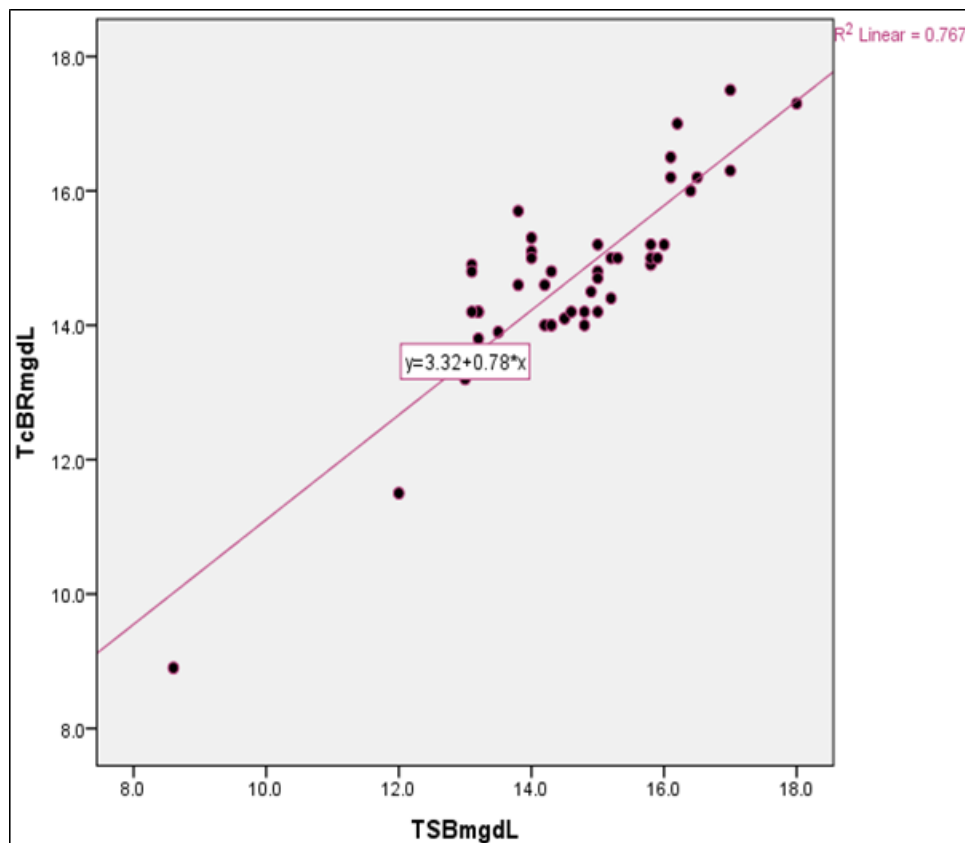


Fig 2: Scatter plot showing TcB and TSB

Table 3: Distribution of complication among the neonates

Complications	Frequency	Percent
Neonatal hyperbilirubinemia	41	82%
Neonatal hyperbilirubinemia+ diabetic mother	3	6%
Neonatal hyperbilirubinemia+ patent foramen ovale	2	4%
Neonatal hyperbilirubinemia+ transient tachypnoea of newborn	2	4%
Small for gestational age	1	1%
Transient tachypnoea of newborn	1	2%
Total	50	100%

DISCUSSION

The study by Mazrah Mohamed *et al.*⁸ found nearly identical results regarding the distribution of males and females, gestational age (>35 weeks), birth weight of >2500 grammes, and mode of delivery.

The mean transcutaneous bilirubin (TcB), measured at the forehead, was 2.5 mg/dL in the study by Mazrah Mohamed *et al.*⁸ while the mean total serum bilirubin (TSB) was 2.6/dL. Additionally, TcB undervalues TSB at the forehead, with a mean difference of 0.1 $\mu\text{mol/L}$. While the total bilirubin by both methods was significantly greater than the present study findings, a positive linear connection was seen between TSB and TcB forehead that was equivalent to the present study findings, with a mean difference of 0.3 mg/dL. The earlier study found a $r = 0.8$, which was comparable to our study's $r = 0.76$.

In Canada, a study led by Rodríguez-Capote *et al.*⁹ involved infants who were beyond 35 weeks gestation, of which half were Caucasian. They

discovered a strong link between the two devices' estimates of TSB and TcB, with TcB underestimating TSB values, which is consistent with the current investigation.

In spite of a strong correlation ($r = 0.84$), a study by Engle *et al.*¹⁰ with 304 late preterms and term infants revealed that the transcutaneous bilirubinometer reading tended to underestimate the TSB value in the higher serum bilirubin level.

In a similar vein, Şimşek *et al.*¹¹ study, which involved 250 Turkish neonates older than 36 weeks at birth, similarly revealed that the transcutaneous bilirubinometer device was used to underestimate TSB readings.

Given the same gestational ages of the newborns participated in the trials, it is probable that the TcB in our investigation and the previously stated studies are similar. We also hypothesised that it would be feasible due to the infants' same skin tones, which contributed to their identical TcB underestimate.

Skin tone variations and racial variance may be factors in the discrepancy between the TSB estimate values obtained from our study and the earlier investigations. When compared to TSB, TcB levels are typically exaggerated in ethnicities with darker skin tones, such as Indians and Black Africans. Research conducted in India by Jandial *et al.*¹² and Africa by Olusanya *et al.*¹³ likewise shown an overestimation of TcB in comparison to TSB; this overestimation may lead to phototherapy treatments for infant jaundice that aren't necessary.

This study discovered a high linear correlation ($r = 0.76$) between TSB and the mean TcB forehead. This finding is consistent with research by Taylor *et al.*¹⁴ that demonstrated a strong connection between TSB and TcB values using data from 27 nursery sites and 925 matched TcB and TSB levels from the forehead and chest.

Mansouri *et al.*¹⁵ in Iran discovered a strong link between 200 neonates' TSB and TcB foreheads, despite using a broader range of neonatal ages between 1 day and 22 days. Our findings concurred with those of studies carried out in Thailand, India, and Hong Kong, among other Asian nations^{16,17}.

CONCLUSION

TcB values and TSB values were found to have a strong linear relationship in the study. TcB measurements at the forehead or sternum demonstrated good diagnostic accuracy for differentiating neonates requiring phototherapy. This is particularly important in managing severe hyperbilirubinemia in neonates with a TSB greater than 14 mg/dL, where the TcB estimation may not be a reliable estimate of the TSB. Although a bilirubinometer is a convenient and safe non-invasive screening tool for non-severe hyperbilirubinemia in South Indian neonates, when it comes to patients with severe hyperbilirubinaemia, caution and it is recommended to use the TSB instead of relying solely on TcB.

CONFLICT OF INTEREST: None.

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