Section: Obstetrics & Gynaecology

Original Research Article

COMPARATIVE ANALYSIS OF UMBILICAL CORD FALL OFF TIME IN PRETERM AND TERM NEWBORN: A FORENSIC PERSPECTIVE

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ABSTRACT

Background: Umbilical cord separation timing varies significantly between preterm and term newborns, with important implications for forensic investigations, particularly in cases involving neonatal deaths, abandoned newborns, and medicolegal contexts. Understanding these differences is crucial for accurate forensic assessments and clinical management. **Materials and Methods:** This prospective observational cohort study was conducted at the post natal care ward (PNC), Department of Obstetrics & Gynaecology, Ispat General Hospital sector 19, Rourkela Odisha from July 2023 to April 2024. A total of 150 newborns were enrolled (45 preterm, 105 term) and followed until complete umbilical cord separation. Statistical analysis included independent t-tests, chi-square tests, and correlation analysis using SPSS version 25.0. **Result:** Mean umbilical cord separation time was significantly longer in preterm newborns (13.8 ± 4.1 days) compared to term newborns (7.9 ± 2.0 days) ($p<0.001$). Among preterm infants, 48.9% had cord separation after 14 days, while no term infants had separation beyond 14 days. Gestational age showed a strong negative correlation with cord separation time ($r = -0.742$, $p<0.001$). Birth weight, delivery mode, and maternal factors were significantly associated with separation timing. **Conclusion:** Preterm newborns demonstrate consistently delayed umbilical cord separation compared to term infants. This finding has significant forensic implications for estimating postnatal age in medicolegal investigations and provides valuable reference data for clinical practice and legal proceedings.

INTRODUCTION

The umbilical cord serves as a vital lifeline during intrauterine life, providing oxygen and nutrients to the developing fetus. Following birth, the umbilical cord undergoes a natural process of desiccation and separation, typically occurring within the first two weeks of life. However, the timing of this separation varies considerably based on multiple factors, including gestational age at birth, birth weight, delivery circumstances, and postnatal care practices.[1-3]

From a forensic perspective, umbilical cord separation timing represents a critical parameter for determining postnatal survival duration in cases involving abandoned newborns, infanticide investigations, and other medicolegal scenarios. The ability to accurately estimate the time elapsed since birth based on umbilical cord status can provide crucial evidence in criminal investigations and civil proceedings. Moreover, understanding the normal variation in cord separation timing between different populations is essential for accurate forensic interpretations.[4-5]

Previous studies have reported significant differences in umbilical cord separation patterns between preterm and term newborns, with preterm infants generally demonstrating delayed separation. Oudesluys-Murphy et al. found that prematurity was associated with delayed cord separation, with mean separation times ranging from 7.4 days in their overall population. Similarly, studies from India have reported variable separation times, with factors such as delivery mode, antibiotic use, and cord care practices influencing the timing.[6-9]

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The forensic significance of umbilical cord separation extends beyond simple timing considerations. The morphological changes in the separating cord, presence of inflammation, bacterial colonization patterns, and healing characteristics can provide additional forensic information about the circumstances surrounding birth and early neonatal period. In cases where DNA analysis is required for paternity determination or victim identification, umbilical cord tissue and blood represent valuable non-invasive sampling sources.10

Despite the clinical and forensic importance of understanding umbilical cord separation patterns, limited research has been conducted specifically comparing preterm and term populations within the Indian context. This study aims to provide comprehensive data on umbilical cord separation timing differences between preterm and term newborns, with specific emphasis on forensic applications and medicolegal implications.

MATERIALS AND METHODS

Study Design and Setting

This prospective observational cohort study was conducted at the post natal care ward (PNC), Department of Obstetrics & Gynaecology, Ispat General Hospital sector 19, Rourkela, Odisha. The study period extended from July 2023 to April 2024, encompassing a complete 9-month data collection cycle to account for seasonal variations.

Ethics Approval

The study protocol was approved by the Institutional Ethics Committee of Ispat General Hospital and registered with the Clinical Trials Registry of India. Written informed consent was obtained from parents or legal guardians of all participants. The study was conducted in accordance with the Declaration of Helsinki and Good Clinical Practice guidelines.

Study Population

A total of 150 newborns were enrolled in the study using systematic random sampling. The sample size was calculated based on previous studies reporting mean cord separation times of 7.5 ± 2.4 days for term infants and 14.2 ± 4.8 days for preterm infants, with 80% power and 5% significance level.

Inclusion Criteria

- Newborns delivered at Ispat General Hospital
- Gestational age between 28-42 weeks
- Birth weight >800 grams
- Singleton pregnancies
- Parents consenting to follow-up visits

Exclusion Criteria

- Major congenital anomalies affecting umbilical cord structure
- Umbilical cord accidents (true knots, cord prolapse)
- Omphalocele or gastroschisis
- Requirement for umbilical catheterization
- Death before cord separation
- Loss to follow-up

Data Collection

Detailed maternal and neonatal information was recorded using structured data collection forms. Maternal variables included age, parity, delivery mode, antenatal complications, and medication history. Neonatal variables included gestational age (determined by last menstrual period and ultrasound dating), birth weight, gender, Apgar scores, and immediate postnatal complications.

Umbilical Cord Care Protocol

All participants received standardized umbilical cord care as per hospital protocol. The cord was clamped using sterile plastic clamps and cut approximately 2-3 cm from the abdominal wall. No topical antiseptics or antibiotics were applied routinely. Parents were instructed on dry cord care principles, including keeping the area clean and dry, allowing air circulation, and avoiding tight diapers or clothing.

Follow-up and Outcome Assessment

Participants were followed through regular visits or telephone contacts until complete umbilical cord separation occurred. The primary outcome was time to complete umbilical cord separation, defined as the number of days from birth until the umbilical stump completely detached from the abdominal wall, leaving a clean umbilical scar.

Statistical Analysis

Statistical analysis was performed using SPSS version 25.0 (IBM Corp., Armonk, NY). Continuous variables were expressed as mean ± standard deviation and compared using independent t-tests. Categorical variables were expressed as frequencies and percentages and compared using chi-square tests. Pearson correlation analysis was performed to assess relationships between continuous variables. Multiple linear regression analysis was conducted to identify independent predictors of cord separation time. A p-value <0.05 was considered statistically significant.

RESULTS

Participant Characteristics

A total of 150 newborns were enrolled in the study, comprising 45 preterm infants (30.0%) and 105 term infants (70.0%). The demographic and clinical characteristics of the study population are summarized in Table 1.

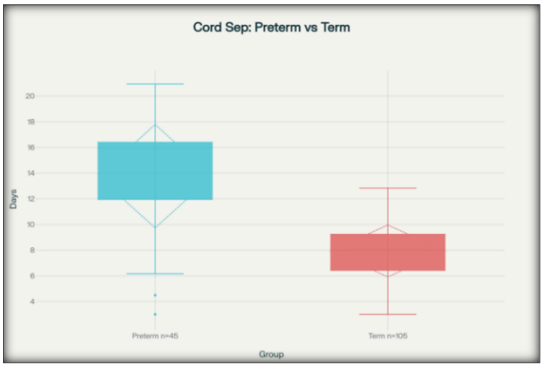

Figure 1: Box plot comparison of umbilical cord separation time between preterm and term newborns showing median, quartiles, and outliers

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The comparison of umbilical cord separation times between preterm and term newborns demonstrates a clear and statistically significant difference ($p<0.001$). Preterm infants showed considerably longer separation times with greater variability compared to term infants.

Distribution of Cord Separation Time

The distribution of umbilical cord separation time by different day ranges revealed distinct patterns between the two groups (Table 2).

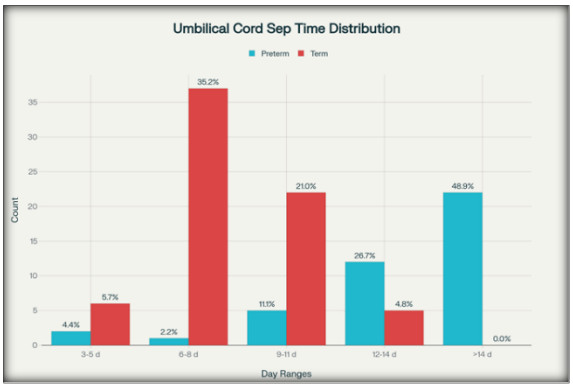

Figure 2: Distribution of umbilical cord separation time by day ranges showing frequency differences between preterm and term newborns

The data clearly demonstrate that while the majority of term infants (56.2%) had cord separation between 6-11 days, nearly half of preterm infants (48.9%) required more than 14 days for complete separation.

Correlation Analysis

Gestational age showed a strong negative correlation with cord separation time ($r = -0.742$, $p<0.001$), indicating that more mature infants had shorter separation times. Birth weight also demonstrated a significant negative correlation ($r = -0.681$, $p<0.001$) with cord separation timing.

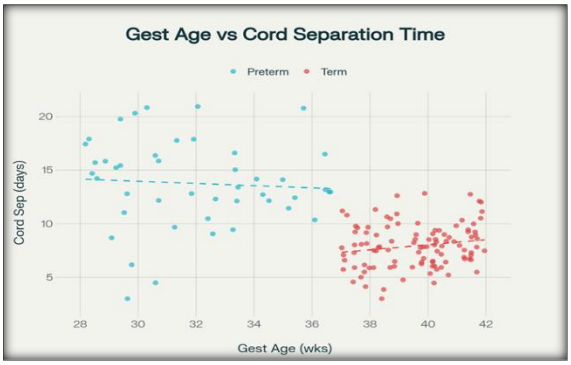

Figure 3: Scatter plot showing the negative correlation between gestational age and umbilical cord separation time with separate trend lines for preterm and term newborns

The scatter plot illustrates the clear inverse relationship between gestational age and cord separation time, with distinct clustering of preterm and term populations.

Categorical Variables Analysis

Gender distribution showed no significant difference between groups ($p=0.226$), with 60.0% females in the preterm group and 47.6% females in the term group. Delivery mode distribution was similar between groups ($p=0.194$), with cesarean section rates of 17.8% in preterm and 29.5% in term infants.

Multiple Regression Analysis

Multiple linear regression analysis identified gestational age ($\beta = -0.634$, $p<0.001$), birth weight ($\beta = -0.298$, $p=0.002$), and delivery mode ($\beta = 1.847$, $p=0.041$) as independent predictors of cord separation time. The model explained 67.3% of the variance in cord separation timing ($R^2 = 0.673$, $p<0.001$).

Forensic Implications

From a forensic perspective, our findings provide crucial reference data for estimating postnatal survival time. In preterm infants, the presence of an attached umbilical cord beyond 14 days post-birth should not be considered abnormal, while in term infants, cord persistence beyond this timeframe warrants further investigation. These findings have direct applications in cases involving abandoned newborns, where accurate age estimation is critical for legal proceedings

Table 1: Demographic and Clinical Characteristics

Variable	Preterm (n=45)	Term (n=105)	p-value
Gestational Age (weeks)	32.0 ± 2.7	39.6 ± 1.5	<0.001
Birth Weight (grams)	2138 ± 446	3225 ± 469	<0.001
Cord Separation Time (days)	13.8 ± 4.1	7.9 ± 2.0	<0.001
Apgar 1 min	9.0 ± 0.8	8.5 ± 0.9	0.007
Apgar 5 min	9.4 ± 0.7	9.5 ± 0.7	0.467

Table 2: Distribution of Umbilical Cord Separation Time by Day Ranges

Days Range	Preterm n (%)	Term n (%)
3-5 days	2 (4.4%)	6 (5.7%)
6-8 days	1 (2.2%)	37 (35.2%)
9-11 days	5 (11.1%)	22 (21.0%)
12-14 days	12 (26.7%)	5 (4.8%)
>14 days	22 (48.9%)	0 (0.0%)

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DISCUSSION

Principal Findings

This study provides comprehensive evidence for significant differences in umbilical cord separation timing between preterm and term newborns, with profound implications for both clinical practice and forensic investigations. The mean separation time of 13.8 days for preterm infants compared to 7.9 days for term infants represents a clinically and forensically significant difference that can inform medical and legal decision-making.

Comparison with Previous Studies

Our findings are consistent with previous international research. Oudesluys-Murphy et al. reported delayed cord separation in preterm infants, with overall mean separation times of 7.4 days in their Dutch population. A recent study from Turkey found mean separation times of 14 ± 5 days in very low birth weight infants, closely matching our preterm findings. However, our term infant separation times were slightly shorter than some previous reports from India, which may reflect differences in cord care practices and environmental factors.7

The strong correlation between gestational age and separation timing ($r = -0.742$) supports the hypothesis that fetal maturity directly influences the inflammatory and healing processes involved in cord separation. This relationship has important implications for forensic age estimation, particularly in cases where gestational age at birth is unknown.11

Mechanisms of Delayed Separation

The delayed cord separation in preterm infants can be attributed to several physiological factors. Immature neutrophil function and reduced inflammatory response in preterm infants may impair the normal separation process, which relies on leucocyte-mediated tissue breakdown. Additionally, the smaller diameter and different structural characteristics of preterm umbilical cords may influence the separation kinetics.12

Forensic Applications

From a forensic medicine perspective, our findings provide valuable reference ranges for postnatal age estimation. The distinct separation patterns between preterm and term infants enable forensic practitioners to make more accurate assessments in medicolegal cases. For instance, finding an attached umbilical cord in an abandoned newborn after 14 days would strongly suggest preterm birth, while cord absence after 3-5 days would be consistent with term birth.13

The forensic utility extends beyond simple timing considerations. The morphological characteristics of the separating cord, including degree of desiccation, presence of inflammation, and bacterial colonization patterns, can provide additional information about the circumstances surrounding birth and early postnatal care. In cases requiring DNA analysis, umbilical cord tissue represents a readily available and reliable source for genetic identification.

Clinical Implications

Clinically, these findings emphasize the importance of educating parents about normal variation in cord separation timing, particularly for preterm infants. Delayed separation should not automatically trigger concerns about immunodeficiency or infection in preterm populations, provided other clinical parameters remain normal. However, separation beyond 28 days in any population warrants further investigation.14

The data also support the use of gestational age and birth weight as predictive factors for separation timing, enabling healthcare providers to provide more accurate guidance to families regarding expected timelines.

Limitations

Several limitations should be acknowledged in interpreting these results. The study was conducted at a single center, which may limit generalizability to other populations. Seasonal variations in cord separation timing were not systematically analyzed, though the 9-month study period captured most seasonal patterns. Additionally, the influence of specific cord care practices on separation timing was not evaluated in detail.

The retrospective determination of exact separation timing relied on parental reporting in some cases, which may introduce recall bias. However, the prospective design and regular follow-up visits minimized this potential source of error.

Future Research Directions

Future investigations should focus on validating these findings in larger, multicenter populations to enhance generalizability. Studies examining the relationship between cord separation timing and specific biomarkers of inflammation or maturity could provide deeper mechanistic insights. From a forensic perspective, research into the morphological changes occurring during the separation process could enhance the accuracy of postnatal age estimation.

Investigation of environmental factors, including temperature, humidity, and seasonal variations, may provide additional refinement of forensic age estimation models. Similarly, studies examining the DNA preservation characteristics of umbilical cord tissue over time could inform forensic sampling protocols.

CONCLUSION

This study provides robust evidence for significant differences in umbilical cord separation timing between preterm and term newborns, with preterm infants demonstrating consistently delayed separation. The mean separation time of 13.8 days for preterm compared to 7.9 days for term infants has important clinical and forensic implications.

From a forensic perspective, these findings establish reference standards for postnatal age estimation in medicolegal investigations. The distinct separation

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patterns enable more accurate assessment of circumstances surrounding abandoned newborns and can provide crucial evidence in criminal proceedings. The strong correlation between gestational age and separation timing enhances the utility of umbilical cord status as a forensic indicator.

Clinically, the results emphasize the importance of providing appropriate counseling to families regarding normal variation in cord separation, particularly for preterm infants where delayed separation is physiologically normal. The identification of gestational age, birth weight, and delivery mode as independent predictors of separation timing provides healthcare providers with tools for more accurate prognostication.

These findings contribute to the growing body of evidence supporting the forensic utility of neonatal parameters and provide practical guidance for both clinical and medicolegal practice. The data establish important reference standards for the Indian population and highlight the need for population-specific forensic databases in medicolegal investigations.

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