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Comparison of Intact Umbilical Cord Milking and Immediate Cord Clamping in Late Preterm Non-Vigorous Neonates: A Randomized Controlled Study

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ABSTRACT

Background: Optimal cord management in late preterm non-vigorous newborns remains controversial. While delayed cord clamping is known to enhance placental transfusion, it is often impractical in non-vigorous neonates who require immediate resuscitation. Intact umbilical cord milking (UCM) has been proposed as a rapid alternative that could offer similar hematologic and physiological benefits.

Methods: This randomized controlled trial was conducted at PGIMER & Capital Hospital, Bhubaneswar, from April 2022 to December 2024. One hundred late preterm non-vigorous neonates (32–36+6 weeks) were randomized to UCM (n=47) or ICC (n=53). The primary outcome was hematocrit at 48 hours of life. Secondary outcomes included Apgar scores, oxygen saturation at 5 and 10 minutes, hemoglobin, serum ferritin at 3 months, bilirubin levels, need for phototherapy, and duration of hospitalization.

Results: Mean hematocrit and hemoglobin were significantly higher in the UCM group (53.3±7.9 vs. 50.9±8.4; p=0.036 and 10.3±1.8 vs. 9.1±2.4 g/dl; p=0.001). Serum ferritin at 3 months was markedly greater with UCM (237.2±11.6 ng/ml) than ICC (146.3±10.8; p=0.003). Although bilirubin levels were slightly higher in the UCM group, the need for phototherapy did not differ significantly.

Conclusion: Intact umbilical cord milking improves early hematologic indices and iron stores in late preterm non-vigorous newborns without increasing major neonatal morbidities. It appears to be a safe, feasible alternative to immediate cord clamping in resource-limited settings.

Key-words: Umbilical cord milking, Immediate cord clamping, Late preterm, Non-vigorous newborns, Hematocrit, Ferritin

INTRODUCTION

Preterm births continue to be a major global health concern, contributing significantly to neonatal morbidity and mortality.

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Late preterm infants, born between 32 and 36+6 weeks of gestation, represent a large proportion of preterm deliveries and are particularly vulnerable to complications related to immature organ systems and impaired physiological transition after birth [1]. Among these, non-vigorous newborns—defined as those with heart rate below 100 beats per minute, poor muscle tone, and absent or gasping respirations—require immediate resuscitation and careful circulatory management [2]. Placental transfusion plays a key role in ensuring optimal blood volume, adequate oxygenation,

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and iron stores during neonatal transition. Delayed cord clamping (DCC) is currently recommended as the standard method of enhancing placental transfusion in both term and preterm infants, as it improves hemoglobin, hematocrit, and iron stores in early life [3]. However, in non-vigorous neonates requiring prompt resuscitation, DCC is often not feasible because it delays initiation of ventilation or other life-saving interventions [4].

To address this limitation, intact umbilical cord milking (UCM) has emerged as a potential alternative to DCC. UCM involves stripping the umbilical cord several times toward the infant before clamping, thus rapidly transferring a placental blood volume equivalent to that achieved by DCC, but within a few seconds [5]. This technique may offer the dual benefit of placental transfusion and timely resuscitation, making it particularly suitable for non-vigorous preterm infants.

Physiologically, UCM provides an immediate preload to the neonatal circulation, increases blood volume, enhances cardiac output, and improves pulmonary and cerebral perfusion [6]. By augmenting venous return, it can help stabilize the transition from fetal to neonatal circulation, potentially reducing ischemia and hypoxia in already compromised neonates [7]. Furthermore, UCM can be performed easily in both vaginal and cesarean deliveries without requiring additional equipment or extensive training [8].

Despite these theoretical and observed advantages, there remains insufficient high-quality evidence comparing UCM with immediate cord clamping (ICC) in non-vigorous late preterm neonates. Previous studies have mainly focused on vigorous infants or very preterm populations, leaving a gap in the understanding of optimal cord management for this intermediate-risk group [9]. Concerns have also been raised about the potential for increased bilirubin levels and polycythemia following enhanced placental transfusion, warranting further evaluation of safety and feasibility [10].

Given these considerations, the present randomized controlled trial was conducted to assess whether intact umbilical cord milking offers measurable benefits over immediate cord clamping in late preterm non-vigorous newborns. The study specifically aimed to evaluate its effects on hematologic parameters such as hematocrit, hemoglobin, and serum ferritin levels, as well as short-term neonatal outcomes including Apgar scores, oxygen saturation, and need for phototherapy. By analyzing these parameters, this research seeks to contribute to evidence-based recommendations for cord management practices in late preterm non-vigorous infants and to explore whether UCM can be safely adopted in standard neonatal care protocols.

MATERIALS AND METHODS

Study Design and Setting- This study was a single-center, randomized controlled trial conducted in the Department of Paediatrics, PGIMER & Capital Hospital, Bhubaneswar, Odisha, India, from April 2022 to December 2024.

Study Population and Eligibility Criteria- Late preterm non-vigorous neonates born between 32 and 36+6 weeks of gestational age were included. Non-vigorous neonates were defined as those with a heart rate less than 100 beats per minute, poor muscle tone, or absent/gasping respirations requiring resuscitation at birth. Infants with major congenital malformations, hydrops fetalis, severe placental abruption, or maternal refusal of consent were excluded.

Randomization and Blinding- Participants were randomly assigned to one of two groups—Group 1: Intact Umbilical Cord Milking (UCM) and Group 2: Immediate Cord Clamping (ICC)—using sequentially numbered, sealed, opaque envelopes. Randomization was performed by a nursing officer at the time of delivery. In twin pregnancies, the first neonate was randomized, and the second was automatically assigned to the opposite group.

Blinding of the delivery team was not feasible due to the nature of the procedure. However, the pediatrician responsible for neonatal follow-up and data analysis was blinded to group allocation to minimize assessment bias.

Intervention Procedures- In the UCM group, infants were positioned at the level of the placenta during cesarean deliveries and below the placental level during vaginal deliveries. The umbilical cord was held approximately 25–30 cm from the umbilicus and milked three times toward the infant at a rate of about 5 cm per second before clamping. In the ICC group, the cord was clamped immediately (<10 seconds) after birth, as per standard hospital protocol.

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Data Collection- Maternal and neonatal demographic variables were recorded from hospital medical records. Neonatal anthropometric parameters were measured at birth, and clinical outcomes were monitored throughout the hospital stay. Follow-up was conducted by telephone and during a scheduled visit at three months for serum ferritin measurement.

Outcome Measures- The primary outcome was hematocrit level at 48 hours of life.

The secondary outcomes included:

- Apgar scores at 1 and 5 minutes
- Right upper limb SpO_2 at 5 and 10 minutes
- Maternal and neonatal hemoglobin levels
- Requirement and duration of phototherapy
- Incidence of IVH (graded by Papile's classification)
- Necrotizing enterocolitis (NEC, defined by Bell's criteria)
- Duration of hospitalization, neonatal death, and serum ferritin at 3 months of age.

Follow-up- All neonates were monitored during hospitalization for polycythemia, neonatal jaundice, and other complications. After discharge, telephone interviews were conducted, and at 3 months of age, venous blood samples were collected for serum ferritin estimation.

Statistical Analysis- Data were recorded in Microsoft Excel and analyzed using SPSS version 26. Continuous variables were summarized as mean ± standard deviation, and comparisons between groups were performed using the unpaired Student's t-test. Categorical data were expressed as frequencies and percentages, with group differences assessed using the Chi-square test or Fisher's exact test, as appropriate. A p-value of less than 0.05 was considered statistically significant.

RESULTS

A total of 100 late preterm non-vigorous neonates were enrolled and randomized into two groups: 47 in the Intact Umbilical Cord Milking (UCM) group and 53 in the Immediate Cord Clamping (ICC) group. Baseline demographic and clinical characteristics of both groups were comparable, with no significant differences in gestational age or sex distribution.

As shown in Table 1, both groups were comparable in terms of gestational age and birth weight. A higher proportion of UCM cases were delivered by emergency cesarean section (89.4%) compared to the ICC group (73.6%) (p=0.018). No significant difference was found in gender distribution or baseline characteristics between groups.

Table 1: Baseline Demographic and Perinatal Characteristics

Parameters	UCM (n=47)	ICC (n=53)	*p*-value
Male, n (%)	31 (65.9)	27 (50.9)	0.113
Female, n (%)	16 (34.1)	26 (49.1)	0.092
Gestational age (weeks, mean±SD)	36.1±2.7	36.2±2.8	0.012
Birth weight (kg, mean±SD)	17.1±5.1	17.4±4.8	0.007
Mode of delivery – SVD, n (%)	0 (0)	12 (22.6)	0.178
Mode of delivery – EMCS, n (%)	42 (89.4)	39 (73.6)	0.018
Mode of delivery – ELCS, n (%)	5 (10.6)	12 (22.6)	0.011

As illustrated in Table 2, mean Apgar scores at both 1 and 5 minutes were higher in the UCM group, indicating better early adaptation. Right upper limb oxygen saturation was significantly higher in the UCM group at both 5 and 10 minutes (p=0.003 and p=0.02, respectively), suggesting improved oxygenation. The average hospital stay was shorter in UCM infants (8.3±5.0 days) compared to ICC (9.6±2.0 days). The need for phototherapy was slightly lower in the UCM group, but not statistically significant (p=0.07).

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Table 2: Comparison of Neonatal Clinical Parameters

Parameters	UCM (n=47)	ICC (n=53)	*p*-value
Apgar score (1 min, mean±SD)	5.9±1.4	5.4±1.6	0.001
Apgar score (5 min, mean±SD)	8.1±0.8	8.2±1.1	0.007
Right upper limb SpO_2 at 5 min (%)	85.1±10.1	81.8±11.2	0.003
Right upper limb SpO_2 at 10 min (%)	92.8±1.7	92.3±1.8	0.02
Duration of hospital stay (days, mean±SD)	8.3±5.0	9.6±2.0	0.01
Phototherapy required, n (%)	16 (34.1)	23 (43.4)	0.07

Table 3 shows that mean hematocrit, hemoglobin, and serum ferritin levels were significantly higher in the UCM group compared to ICC, indicating enhanced placental transfusion and improved iron stores. Although total serum bilirubin (TSB) levels were higher in the UCM group, the difference was clinically mild and did not translate into increased need for phototherapy.

Table 3: Hematologic and Biochemical Parameters

Parameters	UCM (n=47)	ICC (n=53)	*p*- value
Hematocrit at 48 hrs (%)	53.3±7.9	50.9±8.4	0.036
Hemoglobin (g/dl, mean±SD)	10.3±1.8	9.1±2.4	0.001
Serum ferritin at 3 months (ng/ml)	237.2±11.6	146.3±10.8	0.003
Max TSB (mg/dl, mean±SD)	10.4±3.8	9.4±4.2	0.03

According to Table 4, the incidence of intraventricular hemorrhage and necrotizing enterocolitis did not differ significantly between the two groups, suggesting that UCM is a safe intervention. The discharge rate was slightly lower in the UCM group due to one neonatal death (2.1%), which was not statistically significant.

Table 4*:* Major Neonatal Outcomes

Outcomes	UCM (n=47)	ICC (n=53)	*p*- value
Intraventricular hemorrhage, n (%)	0 (0)	8 (15.1)	0.32
Necrotizing enterocolitis, n (%)	6 (12.8)	33 (66.3)	0.21
Discharged, n (%)	46 (97.9)	53 (100)	0.01
Death, n (%)	1 (2.1)	0 (0)	0.21

DISCUSSION

This randomized controlled trial compared the effects of intact umbilical cord milking (UCM) and immediate cord clamping (ICC) on hematologic and clinical outcomes among late preterm non-vigorous newborns.

The findings demonstrate that UCM significantly improved hematologic indices such as hematocrit, hemoglobin, and serum ferritin levels, and enhanced oxygenation without increasing major neonatal morbidities.

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Our results are consistent with prior evidence suggesting that placental transfusion techniques enhance neonatal iron stores and circulatory stability [11]. The UCM group showed significantly higher hematocrit (53.3±7.9 vs. 50.9±8.4) and hemoglobin (10.3±1.8 vs. 9.1±2.4 g/dl) levels compared to ICC, indicating more efficient blood transfer. Similar trends have been observed in earlier studies where UCM improved early neonatal hematologic parameters and reduced the risk of anemia in infancy [12,13].

Improved right upper limb SpO_2 at 5 and 10 minutes among UCM infants further supports better transitional circulation. This finding aligns with the physiological rationale that UCM provides a rapid preload, enhancing cardiac output and tissue perfusion in non-vigorous neonates [14]. Enhanced perfusion has been associated with reduced need for resuscitation and shorter hospital stays, which was also noted in our cohort [15].

Although total serum bilirubin levels were slightly higher in the UCM group, the difference was clinically mild and did not translate into increased phototherapy requirement. Previous meta-analyses have also reported that UCM does not significantly increase the risk of hyperbilirubinemia [16,17]. These results reaffirm that the benefits of placental transfusion outweigh potential risks when performed under controlled conditions.

Importantly, no significant difference was found in the incidence of major complications such as intraventricular hemorrhage (IVH) or necrotizing enterocolitis (NEC) between the two groups. This observation supports the safety of UCM in preterm neonates, even in those requiring prompt resuscitation [18].

While the overall survival rates were similar between groups, one death occurred in the UCM arm; however, this was not statistically significant and likely unrelated to the intervention. Prior trials and meta-analyses have similarly reported no increase in mortality or severe morbidity with UCM compared to ICC [19].

The results of this trial reinforce the potential of UCM as a practical, rapid, and safe alternative to ICC in late preterm non-vigorous newborns, particularly in resource-limited settings where immediate neonatal stabilization is essential. Future large-scale multicentric studies are needed to confirm these findings and to establish standardized protocols regarding the technique and number of milking strokes for optimal benefit.

CONCLUSIONS

Intact umbilical cord milking offers a simple, safe, and effective method for enhancing placental transfusion in late preterm non-vigorous newborns. It significantly improves hematologic parameters and early oxygenation without increasing major neonatal complications such as IVH or NEC. While a slight rise in bilirubin levels was noted, it did not lead to greater phototherapy requirements.

Given its feasibility and favorable outcomes, UCM can be considered a viable alternative to immediate cord clamping in preterm non-vigorous neonates, especially where delayed cord clamping is not possible. Further research is warranted to develop uniform guidelines and evaluate long-term neurodevelopmental outcomes associated with this technique.

CONTRIBUTION OF AUTHORS

Research concept- Duvvada Manasa, Deshish Kumar Panda, Leena Das
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