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AN ANALYTICAL RESEARCH COMPARING PERIPHERAL VENOUS BLOOD CULTURE AND UMBILICAL CORD BLOOD CULTURE FOR THE DIAGNOSIS OF EARLY-ONSET NEONATAL SEPSIS

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Abstract
Early detection of neonatal sepsis has proven challenging in developing nations. The limited sensitivity of some blood biomarkers, such as fibrinogen, haptoglobin, and C-reactive protein (CRP), that can be used as broad indications of bacterial sepsis has raised doubts about their usefulness. Therefore, the purpose of the current study was to compare the assessment of AEONS by UCB and PBC. For our prospective investigation, a total of 88 newborn neonates were selected. We collected clinical data and conducted routine laboratory testing. For both aerobic and anaerobic blood cultures, we used 1 ml aseptically obtained blood samples. Using MedCalc's online statistical calculator, we assessed PCB and UBC's diagnostic test sensitivity and specificity. Intrapartum antibiotic exposure occurred in 12.5% of instances of clinical sepsis, and placental chorioamnionitis symptoms were observed in 15.27% of cases. Placental chorioamnionitis was confirmed in just one of the two individuals with a single organism UCBC (Streptococcus anginosus). When detecting neonatal sepsis in high-risk neonates, UCBC outperforms venous culture in terms of sensitivity and specificity.

Key words – Sepsis, Early detection of neonatal sepsis, Streptococcus anginosus

Introduction

Among other risk factors, preterm babies (35 weeks) and underweight babies (1500 g) are more prone to get sepsis[1]. The term "late-onset neonatal sepsis" refers to sepsis that manifests within 28 days after delivery, but blood cultures may be used to diagnose it[2]. Although sepsis found within 72 hours after birth is called early-onset neonatal sepsis (EONS), it mainly happens due to bacteria passing from mother to baby, leaking amniotic fluid, long labor (over 18 hours), bad-smelling fluids, fever in the mother, being born too early (before 37 weeks), and lack of oxygen[3]. It is crucial to create a separate NICU since 60% of neonates with EONS experience respiratory distress and need circulatory support. Moreover, gram-positive and gram-negative bacteria and a variety of fungi (including streptococcus, E. coli, and others) were shown to be responsible for bacteremia, meningitis, and pneumonia in EONS babies[4]. Nevertheless, the most challenging duty is to identify the infection-causing agent totally, precisely, and properly. Peripheral and umbilical cord blood cultures were conducted to determine if bacteria were present in the blood[5]. Research on blood culture volume showed that using less blood makes it harder to find microorganisms, which can lead to missed diagnoses of sepsis and incorrect

negative results[6]. But the gold standard for newborn sepsis is the identification of bacteria in peripheral blood, and blood culture requires at least 1.0 ml of blood volume. Blood culture uses umbilical cord blood as a backup source of blood (UCB). UCB has been used for blood type, antibody screening, and chromosomal analysis up till now. When compared to peripheral blood, UCB has an 80–100% sensitivity and 91–95% specificity, making it useful for diagnosing sepsis[7]. Additionally, UCB is less painful to take than peripheral blood, which is still the recommended technique for identifying neonatal sepsis but has to be obtained in sufficient amounts and without contamination. A peripheral blood culture takes a lot of time and money. Thus, both developed and poor countries have had difficulty detecting infant sepsis early. Serum proteins that may be used as broad indicators of bacterial sepsis include fibrinogen, haptoglobin, and C-reactive protein (CRP). Despite its low sensitivity, some have questioned the effectiveness of CRP in detecting infections in newborns. In cases of early-onset neonatal sepsis, the regular use of umbilical cord blood cultures is supported by less published research[8]. This research will evaluate the efficacy of peripheral vein blood culture against umbilical cord blood culture in infants at high risk for early-onset neonatal sepsis. Therefore, comparing the development of EONS via UCB and PBC was the goal of the present investigation.

Materials and methods

The present prospective, observational research was conducted at the Varun Arjun Medical College and Rohilkhand Hospital in Banthra District, Shajahanpur, Uttar Pradesh, India. In June 2022, the proposal was first accepted by the local ethics committee. The research was carried out between March 1st, 2022, and September of the same year. Mothers who were willing to sign the permission form were the only ones selected for the study. Only moms who satisfied the following requirements were chosen with the help of OBG department professionals. They selected mothers with specific conditions, such as early water breakage (after 37 weeks), prolonged water breakage (more than 18 hours), prolonged labor (more than 24 hours), an infection-indicating point i.e. , a high fever (above 100.4°F), the need for delivery tools, low Apgar test scores at 1 minute, low birth weight (less than 2500 grams), and signs of asphyxia[9]. Cefotaxime injections were given to moms who had cesarean sections, whereas ampicillin and gentamicin injections were given to all mothers who gave birth regularly. Crucially, the research excluded neonates without high-risk indicators for sepsis or with congenital metabolic abnormalities in accordance with the guidelines for neonatal sepsis. Additionally, kids born outside of hospital, babies with metabolic abnormalities, congenital problems, newborns with no risk factors, newborns whose guardians did not provide written permission, and newborns who fled the hospital against medical advice were not included in our analysis. Ultimately, 88 newborn neonates in all were chosen for our prospective investigation. Obtaining blood samples[10]: Following delivery, the umbilical cord will be clamped on the newborn's and placenta's sides. The cable will be sterilely cleaned with 70% isopropyl alcohol. Using a sterile 22-gauge needle and syringe, we will extract about 3.5 to 4 cc of blood from the umbilical vein and transfer it into the container. We'll take a fresh, sterile needle out of the syringe and use alcohol to clean the top of the culture container. 1.5 ml of blood will be added to the aerobic blood culture vial, and the remaining blood sample will be sent to the laboratory for a sepsis screening. We shall sterilely draw peripheral vein blood in a different culture container and label it after providing standard care. Both culture samples will be immediately sent to the microbiology lab for aerobic blood culture and organism identification using the manual technique. BHI broth is found in blood culture bottles, which are used for the manual blood culture procedure. After then, blood and MacConkey agar will be subcultured every other day until the seventh day. If there is no improvement in the subculture on day seven, we shall provide a bad report. A fever or hypothermia are two clinical indicators of sepsis that we will look for in the infant. Abdominal distention, intercostal retractions, grunting, poor perfusion, extended capillary refill time, hypotonia, weak cry, unwillingness to suck, and lack of newborn reflexes Among the symptoms to watch for include hypotension, hypoglycemia/hyperglycemia, pallor, odd skin color, bradycardia/tachycardia, metabolic acidosis, sclerema, shock, and signs of disseminated intravascular coagulation. Standard laboratory tests were performed and clinical data was collected[10]. One milliliter of aseptically collected blood was used for both aerobic and anaerobic blood cultures. The blood

culture vials were transferred to the automated blood culture apparatus BACTEC-2 FX. We took the vials out of the machine and subcultured them on MacConkey agar and blood agar plates after determining a positive result. The isolated species on culture plates were identified by biochemical analysis. Following standard laboratory procedures, an antibiotic susceptibility test was conducted. Bacterial culture was done at our hospital's clinical microbiology lab. All of the samples were collected in two hours. Utilizing the MicroScan WalkAway-96 System (Siemens, USA), the kind of bacteria was identified[11]. We measured the amounts of CRP in serum using the IMMAGE 800 specific protein analysis device (Beckman Coulter business, USA). To assess the efficacy of the therapies, we collected information on eligible admissions, maternal and neonatal features, UBC, PBC, and placental pathology findings. For data analysis, we used the SPSS version 22.0 software program (SPSS Inc., Chicago, USA) to calculate the mean values and standard deviations (SD) of all quantitative variables. Clinical information and a history of medical treatments were included on the data collecting sheet.

Table 1 Baseline characteristics of neonates and mother (n=72)

S.L.	Parameters	Observation	Statistics (%^{age})
1	**Sex ration M/F**	30/42	41.66/58.33
2	**Weight (g)**	1255.7±113.4	
3	**Delivery type (C- section,% age)**	40	55.55
4	**Maturity in week**	34±2.9	
5	**Prolonged rupture of membrane**	32	44.44
6	**Maternal intrapartum antibiotics**	9	12.5
7	**Placental chorioamnionitis (%age)**	11	15..27
8	**Premature birth**	52	72.22
9	**Maternal temperature (F±SD)**	100.8±1.1	
10	**CRP (negative / positive)**	62/10	86.11/13.88

Note – Mean ± SD

Table -2 Comparison of presence of microorganism in blood culture and their relation with neonatal sepsis

S.L.	Presence of microorganisms	Number of cases	UCB culture	PB culture	Neonatal sepsis
1	**Escherichia coli**	1	Positive	Positive	Yes
2	**Streptococcus mitis**	1	Positive	Negative	No
3	**Streptococcus anginosus**	4	Positive	Positive	Yes
4	**Staphylococcus hemolyticus**	7	Positive	Negative	No
5	**Enterococcus faecalis**	4	Positive	Negative	No
6	**Citrobacter freundi**	6	Positive	Negative	No

Note – UCB- Umbilical cord blood, PB- Peripheral Blood

Results

The baseline characteristics of the neonates and their mothers reveal several clinically significant patterns. A majority of the neonates were female (58.33%), and the average birth weight was notably low at 1255.7 ± 113.4 g, indicating that most infants fell within the very low birth weight (VLBW) category, which is a known risk factor for neonatal morbidity and mortality.

The mean gestational age of 34 ± 2.9 weeks confirms a predominance of preterm births, which is further substantiated by the fact that 72.22% of the neonates were born prematurely. This aligns with the elevated rate of cesarean section deliveries (55.55%), which is commonly higher in preterm and high-risk pregnancies.

Prolonged rupture of membranes (PROM) was observed in 44.44% of the cases. PROM is a known risk factor for neonatal infection and is often associated with preterm labor. In this context, 15.27% of mothers had placental chorioamnionitis, an inflammatory condition often linked with PROM and preterm birth, which may also contribute to adverse neonatal outcomes, including sepsis and respiratory distress.

Despite these risks, only 12.5% of mothers received intrapartum antibiotics, which appears relatively low given the prevalence of PROM and chorioamnionitis. This suggests a potential area for improvement in intrapartum care and infection prevention strategies.

Maternal temperature averaged 100.8°F, slightly above normal, which may indicate underlying infection or inflammation during labor, further supported by the presence of positive C-reactive protein (CRP) in 13.88% of neonates. CRP is a biomarker for inflammation and may reflect neonatal sepsis or exposure to intrauterine infection.
The data presented in Table 2 highlights the microbial profile found in umbilical cord blood (UCB) and peripheral blood (PB) cultures, and its correlation with clinically diagnosed neonatal sepsis. The findings suggest that not all positive UCB cultures are indicative of neonatal sepsis, underlining the importance of confirming results with PB cultures and clinical evaluation.

Out of the six microorganisms isolated, only two organisms—Escherichia coli and Streptococcus anginosus—were found in both UCB and PB cultures and were clinically associated with neonatal sepsis. This dual positivity strengthens their causative link to sepsis, reflecting their ability to translocate into systemic circulation and elicit a pathogenic response in the neonate.

In contrast, Streptococcus mitis, Staphylococcus hemolyticus, Enterococcus faecalis, and Citrobacter freundii were only isolated in UCB cultures and not associated with clinical sepsis. These findings raise the possibility that these organisms may represent contamination during collection, transient colonization, or non-pathogenic commensals that do not necessarily lead to infection. For example, S. mitis and S. hemolyticus are often considered part of the normal flora and may have limited invasive potential in neonates unless associated with other risk factors.

This discrepancy between UCB culture positivity and clinical sepsis emphasizes the limited specificity of UCB cultures alone as a diagnostic tool for neonatal sepsis. Relying solely on UCB results may lead to overdiagnosis and unnecessary antibiotic use. Therefore, concurrent PB cultures and clinical correlation remain essential to establish a definitive diagnosis.

Discussion

The quantity of blood required to get a favorable result is a crucial consideration. More than milliliters of blood are required for the best pathogenic organism recovery from blood. Because the peripheral veins of preterm babies are tiny and sensitive, it is sometimes difficult to get milliliters of blood from them. The diagnosis of neonatal sepsis mainly requires the isolation of pathogenic organisms on blood cultures. Even if repeated isolation of the same bacteria establishes its causal role in sepsis, it is sometimes impossible to withhold drugs in the presence of several risk factors and sepsis indicators. Consequently, the antimicrobial impact of empirical antibiotics reduces the possibility of recovery of causative bacteria in culture if empirical antibiotic therapy is started before blood collection for PVBC. Ten out of 29 patients (34.5%) with negative septic screens and five out of eleven cases (45.4%) with positive septic screens had protracted rupture of membranes, according to a risk factor analysis. Odabaşı O et al. claim that in newborns with maternal risk factors, UCBC may replace or even augment PVBC[2,5,7,9]. Both maternal (such as prolonged and/or premature membrane rupture, foul-smelling or meconium-stained liquor, prolonged labor, maternal fever, and frequent vaginal examination) and neonatal (such as prematurity, low birth weight, and birth asphyxia) characteristics

have been associated with an increased risk of developing EONS. Fos et al. determined that UCBC was a more straightforward choice than PVBC 15 after looking at 30 neonates[12]. The umbilical cord provides a sufficient quantity of neonatal blood. We take cord blood as soon as the infant is delivered to prevent the side effects of antibiotics. Smaller volumes of cord blood have been shown to be more beneficial than venous blood, particularly in instances of EONS associated with intrauterine sepsis. UCBC provides a straightforward alternative to traditional PVBC in order to overcome these drawbacks of PVBC. In a research by Özmeral O et al., UCBC was shown to be a useful method to enhance the etiological diagnosis of bloodstream infection in high-risk infants. Research has shown that in certain circumstances, UCBC is superior than PVBC. Pollin et al. discovered that six UCBC cultures were positive out of 200 samples examined. Only one of these cultures was considered noteworthy and showed a clinical correlation. The cord blood collection procedure has to be flawless in order to provide precise results free of contamination[13]. Skilled medical professionals used the proper sterile equipment to replicate the study's samples in order to minimize contamination and meet our investigation's goals. According to the Pollin et al. investigation, PBC only recovered eight bacterial isolates, whereas UBC recovered 11 isolates with a sensitivity of 80% and specificity of 91.4%. Six of the eleven infants who tested positive for UBC had the same organisms found in their PBC, they found. Among the isolates, Pseudomonas, Acinetobacter, E. coli, and Klebsiella were the most common bacteria[14]. We isolated Escherichia coli, the same bacterium, from one neonate's cord culture and PBC findings throughout our examination. No pathogen development was seen on PBC in two further newborns with positive cord blood cultures. The reason could be the variation in the amount of blood that PBC and UBC collected for culture. The shorter mean time to indicate good findings for UBC in BACTEC may also be explained by this. The incidence of positive UCBC test results was 0.5% in a research by Pollin et al. In contrast to a positive septic screen for neonatal sepsis, the UBC positivity rate in our study was 713.88%. UCBC and PVBC assessed the EONS status of 45 high-risk neonates in a comparable research from India[15]. They found that the UBC-positive percentage was greater (24.4%) than our research. Multicentric research should be conducted in order to improve knowledge of UCBC and lower mortality in this patient group. The final 28 patients' results showed no differences between PBC and UBC. Of these 28 individuals, 14% had clinical sepsis.

The data highlights a vulnerable neonatal population with high rates of prematurity, low birth weight, and exposure to infection-related maternal conditions such as PROM and chorioamnionitis. These findings underscore the importance of targeted antenatal and perinatal interventions, including timely administration of antibiotics and close monitoring of maternal-fetal health to reduce neonatal complications[16].

The study reinforces the need for careful interpretation of positive UCB cultures, especially in the absence of PB culture confirmation and clinical signs of sepsis. A combined diagnostic approach—including microbiological evidence from both blood sources and clinical assessment—is crucial for accurate diagnosis and management of neonatal sepsis.

Thus, UBC is a less intrusive technique that yields comparable outcomes while preserving neonatal blood. Such data provides compelling support for altering practice. Furthermore, it is simple to remove volumes of 1 ml or more from the umbilical cord using the proper sterile technique. This may thus reassure physicians that the UCBC data are trustworthy.

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