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Effectiveness of Umbilical Cord Blood Culture vs Peripheral Venous Blood Culture in Diagnosis of Early Onset of Neonatal Sepsis

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ABSTRACT

It has been difficult to identify infant sepsis early in poor countries. The utility of some serum biomarkers that can be used as general indicators of bacterial sepsis include C-reactive protein (CRP), haptoglobin, and fibrinogen, has been questioned due to its low sensitivity. So, comparing the evaluation of EONS via UCB and PBC was the goal of the current study. 88 newborn neonates in all were chosen for our prospective study. Standard laboratory testing was performed, and clinical data were obtained. Blood samples (1 ml) that were aseptically acquired were utilized for both aerobic and anaerobic blood cultures. Using MedCalc's online statistical calculator, the diagnostic test sensitivity and specificity of PCB and UBC were evaluated. 12.5% of clinical sepsis cases had intrapartum antibiotic exposure and that placental chorioamnionitis symptoms were present in 15.27 percent of cases. Only one of the two patients with a single organism UCBC had placental chorioamnionitis verified (Streptococcus anginosus). With sensitivity and specificity, UCBC is a superior approach than venous blood culture for the identification of neonatal sepsis in high-risk neonates. The developed organisms are similar to blood culture samples.

Keywords: *Umbilical cord culture; Peripheral venous blood culture; Early onset of neonatual sepsis*

Introduction

Sepsis is more likely to affect newborns who are underweight (1500 g) and premature (35 weeks), among other risk factors [1]. Blood cultures can be used to identify sepsis, but if it develops within 28 days of birth, it is known as late-onset neonatal sepsis [2]. While early onset of neonatal sepsis is the phrase used to describe sepsis that is identified within 72 hours of birth (EONS) [3]. Vertical transfer of bacteria, rapture of the amniotic membrane with leakage, prolonged labour (more than 18 hours), emission of foul-smelling fluids, maternal fever, premature birth (less than 37 weeks), and hypoxia are the main causes of EONS [4]. Because 60 percent of newborns with EONS have respiratory distress and require circulatory support, a dedicated NICU is essential [5]. Additionally, it was discovered that EONS newborns had bacteraemia, meningitis, and pneumonia caused by gram-positive and gram-negative bacteria as well as various fungus (such as streptococcus, E. coli, etc.) [6]. However, the most difficult task is to completely specifically and accurately identify the infection-causing agent.

Blood cultures using peripheral blood and umbilical cord blood were performed to check for the presence of bacteria in the blood [7]. Studies on the volume of blood taken for blood culture revealed that a decrease in the blood volume showed decreased sensitivity in the detection of microorganisms in the culture that indirectly affect the diagnosis of sepsis positive cultures and provide false negative results [8]. However, the

detection of microorganisms in peripheral blood is treated as the Gold Standard for neonatal sepsis and a minimum of 1.0 ml of blood volume is required for blood culture.

Umbilical cord blood is a second supply of blood for blood culture (UCB) [9]. Prior until now, UCB has been utilised for chromosomal analysis, antibody screening, and blood typing [9,10]. Because UCB has an 80–100% sensitivity and 91–95% specificity compared to peripheral blood, it can be utilized to diagnose sepsis. Furthermore, drawing UCB is painless compared to drawing peripheral blood, which is still the preferred method for diagnosing newborn sepsis but must be drawn in sufficient quantities and free of contamination [10].

A periphery blood culture is also expensive and time-consuming. Early detection of newborn sepsis has thus proved challenging in both developing and industrialized nations. C-reactive protein (CRP), haptoglobin, and fibrinogen are examples of serum proteins that can be utilized as general indications of bacterial sepsis [11,12]. However, because to its limited sensitivity, the usefulness of CRP for the detection of newborn infection has been in question. There are fewer documented studies that support the routine use of umbilical cord blood cultures in early-onset newborn sepsis. In this study, the effectiveness of umbilical cord blood culture in contrast to peripheral vein blood culture in newborns at high risk for early-onset neonatal sepsis will be assessed. Therefore, it was intended for the current study to contrast the evolution of EONS via UCB and PBC.

Materials and Methods

The Rajshree Medical Research Institute in Bareilly, Uttar Pradesh, India, was the site of the current prospective, analytical study. The project was initially properly approved by the local ethical committee in December 2020. The study was carried out between the first of February 2021 and the first of September 2022. (Over a period of 12 months).

Study population

Only mothers who were prepared to sign the consent form were chosen. Only moms who met the following criteria were chosen, with the assistance of OBG department professionals: Premature membrane rupture (GA = 37 completed weeks), prolonged membrane rupture (>18 hours), prolonged labour (>24 hours), odorous alcohol (Chorioaminiotis), maternal fever (>100.4F), instrumental delivery (Forceps, ventouse, etc.), perinatal asphyxia (Apgar score 4 at 1 minute), low birth weight 2500 gm, asphyxia. Ampicillin and gentamicin were injected into all moms who gave birth normally, while cefotaxime was injected into mothers who had Caesarean sections [13].

Importantly, as per guidelines of neonatal sepsis, the neonates with congenital metabolic disorder or with no high-risk factors of sepsis were omitted or under exclusion creteria. Furthermore, healthy newborns with no antenatal risk factors, babies with congenital anomalies, babies with metabolic disorder, baby delivered outside RMRI, neonates in whom informed written consent not given by the attendants, neonates who left hospital against medical advice were counted under exclusive criteria. At last total of 88 neonatal infants were selected for our prospective study.

Collection of blood samples

The umbilical cord will be clamped after birth on both the placenta and newborn sides. Isopropyl alcohol (70%) will be used to clean the cord in a sterile manner. A sterile 22-gauge needle and syringe will be used to draw about 3.5 to 4 cc of blood from the umbilical vein into the container. A new, sterile needle will be removed from the syringe, and the top of the culture bottle will be wiped with alcohol. The aerobic blood culture vial will receive 1.5 ml of blood, and the remaining blood sample will be transferred to the lab for a sepsis screen [14].

Following the administration of normal care, peripheral vein blood will be collected sterilely in a separate culture bottle and labelled. Both culture samples will be taken right away to the microbiology lab, where the manual method for aerobic blood culture and organism identification will be carried out. Blood culture bottles are used for the manual method of blood culture and contain BHI broth. Subculture will then be carried out on Blood & MacConkey agar every other day until the seventh day. If there is no improvement in the subculture, a negative report will be given on day seven.

Any clinical sign of sepsis, such as a fever or hypothermia, will be checked on the newborn. Lack of newborn reflexes, hypotonia, poor scream, refusal to suck, abdominal distention, intercostal retractions, grunting, increased aspirates, poor perfusion, prolonged capillary refill time hypotension, hypoglycemia/ hyperglycemia, pallor, unusual skin color, bradycardia/tachycardia, metabolic acidosis, sclerema, shock, and features of disseminated intravascular coagulation are some of the symptoms to look out for [15].

Investigations

Clinical information was gathered, and standard laboratory tests were run. For aerobic and anaerobic blood cultures, aseptically obtained blood samples (1 ml) were used. The automated blood culture device BACTEC-2 FX received the blood culture vials. The vials were taken out of the machine and subculture on blood agar and Mac-Conkey agar plates once a positive result was determined. Biochemical analysis was used to identify the isolated species on culture plates. An antibiotic susceptibility test was performed in accordance with accepted laboratory practices.

The clinical microbiology laboratory of our hospital performed bacterial culture. Within two hours, all samples were gathered18. The bacterial species was determined using the MicroScan WalkAway-96 System (Siemens, USA). The IMMAGE 800 specific protein analysis instrument was used to measure the levels of CRP in serum (Beckman Coulter company, USA).

Data collection and statistical analysis

To evaluate the effectiveness of the interventions, data on eligible admissions, neonate and maternal characteristics, UBC, PBC, and placental pathology results were gathered. All quantitative variables' mean values and standard deviations (SD) were determined using the SPSS version 17.0 software package (SPSS Inc., Chicago, USA) for data analysis. The data collection sheet contained clinical details and a history of medical treatments [8,12,14,16,17].

Results

The purpose of the current study was to compare the effectiveness of umbilical cord blood culture to peripheral vein blood culture in newborns who were at high risk of developing early-onset neonatal sepsis. 72 eligible newborns were chosen for the trial, admitted to the NICU of the RMRI pediatrics unit, and prospectively tracked throughout their hospital stay for the course of the 18-month study period. Table 1 lists the baseline parameters that were recorded, including sex, maturity, weight, umbilical cord blood culture, and peripheral vein blood culture

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

S. No.	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

*Mean ± SD

The UBC and PBC approaches were used to identify the early onset of neonatal sepsis in 30 male and 42 female babies who were classified as having risk factors. The results are reported in table 1. Only 13.88% of babies had higher CRP levels, it was discovered. A total of 144 blood samples, including 72 from the umbilical cord and 72 from the peripheral, were taken. There is no need to miss the chance to take blood samples because healthcare staff and professionals are adequately trained.

The sensitivity and specificity of PCB and UBC as diagnostic tests were assessed using the online statistical calculator provided by MedCalc. According to table 1, 15.27 percent of clinical sepsis cases exhibited placental chorioamnionitis symptoms and 12.5% of those cases had intrapartum antibiotic exposure. Only two of the 12.5% of infants who developed clinical sepsis had single organism growth in their UCBCs, and all had negative PBCs (Escherichia coli and Streptococcus anginosus, Table 2). Placental evidence of chorioamnionitis was present in 15.27 percent of infants who had clinical sepsis. Placental chorioamnionitis had been confirmed in just one of the two patients with a single organism UCBC (Streptococcus anginosus). The isolated organisms from PBC and UBC were listed in Table 2. Table 2 lists the organisms that were isolated in each UCBC.

Table 2: Comparison of presence of microorganism in blood culture and their relationship with neonatal sepsis

S. No.	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

*UCB- Umbilical cord blood, PB- Peripheral Blood

Discussion

A key factor is the amount of blood needed to produce a positive result. For best pathogenic organism recovery from blood, more than 1 ml of blood is needed. It is frequently challenging to collect 1ml of blood from preterm newborns due to the small and delicate nature of peripheral veins [7]. Pathogenic organism isolation on blood cultures is primarily required for the diagnosis of newborn sepsis [8]. It is frequently not possible to withhold medications in the presence of many risk factors and indications of sepsis, even though recurrent isolation of the same bacterium confirms its causative link in sepsis. Therefore, if empirical antibiotic medication is started prior to blood collection for PVBC, the antimicrobial effect of empirical antibiotics diminishes the likelihood of recovery of causal microorganisms in culture [19]. According to a risk factor analysis, protracted rupture of membrane was observed in 10 out of 29 (34.5%) patients with negative septic screens and five out of 11 (45.4%) instances with positive septic screens. According to Odabaşı et al. UCBC may supplement or even take the place of PVBC in neonates who have maternal risk factors. A higher risk of developing EONS has been linked to both neonatal (such as prematurity, low birth weight, and birth asphyxia) and maternal (such as prolonged and/or premature membrane rupture, foul-smelling or meconium-stained liquor, prolonged labour, maternal fever, and frequent vaginal examination) characteristics. After examining 30 neonates, Fos et al. concluded that UCBC was a simpler option than PVBC [15].

An adequate supply of newborn blood can be obtained through the umbilical cord. Since cord blood is taken when the baby is delivered, antibiotic effects are avoided. Smaller amounts of cord blood have been proven to be more effective than venous blood, particularly in cases of EONS linked to intrauterine sepsis [19]. To get over these limitations of PVBC, UCBC offers a simple substitute for conventional PVBC. UCBC was found to be an effective way to improve the aetiological identification of blood stream infection in high-risk newborns in a study by Özmeral O et al. [10].

Studies have shown that UCBC has advantages over PVBC in certain situations. Out of 200 samples tested, six UCBC cultures were found to be positive in research by Pollin et al [16]. Of these, only one culture exhibited a clinical correlate and was deemed significant. To guarantee accurate findings free of contamination, the cord blood collection method must be perfect. For this replication of samples in the study by skilled medical personnel using an appropriate sterile apparatus was done to reduce contamination in order to achieve the objectives of our investigation. As per the study done by Pollin et al, UBC recovered 11 isolates with a sensitivity of 80% and specificity of 91.4% compared to PBC's recovery of eight bacterial isolates16. They discovered that identical organisms were detected in PBC in six out of the 11 neonates who tested positive for UBC. Pseudomonas, Acinetobacter, E. coli, and Klebsiella were the most prevalent bacteria among the isolates [8,19–21]. In our investigation, one neonate had positive cord culture results and PBC results, and the same pathogen was isolated from both cultures (Escherichia coli). Two other infants who had positive cord blood cultures lacked any pathogen growth on PBC. The difference in blood volume collected for culture between PBC and UBC could be the cause. The reduced mean time to signal positive results for UBC in BACTEC may also be explained by this. The positive UCBC test result rate in a study by Pollin et al. was 0.5% [16].

In our investigation, compared to a positive septic screen for newborn sepsis, the UBC positivity rate was 713.88%. In a related study from India by21, 45 high-risk newborns had their EONS status examined by UCBC and PVBC. Compared to our investigation, they discovered a higher UBC positive rate (24.4%). To advance understanding of UCBC and reduce mortality

in this patient population, multicentric studies should be carried out.

Results from the last 28 patients were consistent between UBC and PBC. 14 % of these 28 patients were diagnosed with clinical sepsis. So UBC is a less invasive method that preserves newborn blood and produces equal results. This offers strong justification for changing practice. Furthermore, with the right sterile procedure, quantities of 1 ml or more can be easily extracted from the umbilical cord. As a result, this can provide clinicians comfort that the UCBC data are reliable [17,22].

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Conflict of Interest

The researchers claim that because there were no financial or commercial ties during research, there were no conflicts of interest.

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