Study of Umbilical Cord Blood Culture in Diagnosis of Early-onset Sepsis Among Newborns with High-risk Factors

Mitul Babubhai Kalathia, Prakash Ashokbhai Shingala, Parin Niranjanbhai Parmar, Yogesh Narenderbhai Parikh, Ila Mitulkumar Kalathia
Department of Paediatrics, Pandit Deendayal Upadhyay Medical College and Hospital, K. T. Sheth Children Hospital, 'Consultant Microbiologist, Department of Microbiology, Sree Religare Laboratories, Rajkot, Gujarat, India

ABSTRACT

Context: Blood culture is gold standard for diagnosis of neonatal sepsis. Low sensitivity of blood culture is usually due to small volume of blood sample, intrapartum antibiotics, and antibiotics given to newborn before sampling. Aim: We evaluated use of Umbilical cord blood culture (UCBC) in diagnosis of neonatal sepsis as compared to peripheral venous blood culture. Settings and Design: This study was done in tertiary care teaching hospital during May-June 2012. A total of 45 newborns with presence of two or more risk factors of sepsis were included. Subjects and Methods: Blood sample from placental end of umbilical cord was collected and cultured. Primary outcome was diagnosis of neonatal sepsis by use of umbilical cord blood sample as compared with venous blood sample. Secondary outcome was to compare organisms identified by UCBC and venous blood culture. Statistical Analysis: Sensitivity, specificity, positive and negative predictive values of UCBC were calculated. Results: A total of 24.44% (11 out of 45) high-risk newborns had positive UCBC. A total of 17.8% (8 out of 45) newborns had positive blood culture report. Organisms grown in UCBC were Pseudomonas (45%, 5 out of 11), Acinetobacter (27.27%, 3 out of 11), Escherichia coli (18.18%, 2 out of 11), and Klebsiella (9%, 1 out of 11). Conclusion: UCBC is a good method for diagnosis of neonatal sepsis among high-risk newborns as compared to venous blood culture with a sensitivity of 80% and specificity of 91.43%. Organisms grown are comparable to blood culture samples.

Key words: Blood culture, neonatal sepsis, umbilical cord blood culture

INTRODUCTION

Gold standard for the diagnosis of neonatal sepsis is blood culture collected from peripheral veins. Identification of organism responsible for neonatal sepsis is important as decisions on antibiotics selection and duration of treatment are dependent on it. Variable sensitivity of blood culture is mainly due to inadequate sample volume, intrapartum antibiotics, and administration of antibiotics prior to sample collection. Other sites of blood collection for blood culture are heel prick collection, blood from arterial and central venous lines, and umbilical (neonatal end) vein. Umbilical cord (placental end) is a less commonly used site for collection of blood culture. There are some studies on umbilical cord blood culture (UCBC) for diagnosis of neonatal sepsis, which suggest umbilical cord blood can be collected for blood culture safely and without contamination. We did a study for evaluating UCBC for diagnosis of early neonatal sepsis in high-risk newborns.

SUBJECTS AND METHODS

This study was done at a tertiary care teaching hospital with approval of institutional review board. Study patients were newborns delivered at labour room/cesarean section delivered during May-June 2012. Inclusion criteria: Newborns with birth weight >1500 g and maturity ≥28 weeks, who were attended by pediatric resident at the time of delivery at risk of developing sepsis based on presence of two or more risk factors A convenient sample of 45 newborns with high-risk factors for sepsis was subjected to UCBC. Primary outcome of this study was to study UCBC in diagnosis of early-onset neonatal bacterial sepsis in high-risk newborns as compared to peripheral venous blood culture (PVBC). Secondary outcome was to compare organisms identified by UCBC and PVBC in neonatal sepsis.

Address for correspondence:
Dr. Mitul B Kalathia,
131, Chitrakutdham Society, Kalawad Road,
Rajkot - 360 005, Gujarat, India.
E-mail: dr.mitulkalathia@gmail.com
Newborns delivered during May-June 2012 were assessed at the time of birth for presence of risk factors of developing neonatal sepsis. The risk factors were prematurity (<35 completed weeks), premature rupture of membranes, prolonged rupture of membranes (>18 h), foul smelling liquor, maternal fever (>100.4°F), frequent vaginal examinations (>3), birth asphyxia, prolonged labor (>24 h), low-birth weight (<2.5 kg). [1-4, 6]

Umbilical cord blood samples were collected from 45 newborns with presence of two or more risk factors for neonatal sepsis. Method of umbilical cord blood collection.[13] Clamp the umbilical cord at the placental side and the infant side. Cut the cord between each pair of clamps and hand it off to the nurse. Wipe the cord three times with 70% isopropyl alcohol using sterile technique. Using a sterile 22-gauge needle and syringe, draw approximately 1.5 to 2 mL of blood into the syringe from the umbilical vein or artery from placental end. Replace the needle from syringe with a new sterile needle and wipe the culture bottle top with alcohol. Inject 1 mL of blood in an aerobic blood culture bottle. Send to the laboratory.

All mothers were given injection ampicillin 1 g intravenous (i.v.) case of normal delivery, and inj. cefotaxime 1 g iv and inj. amikacin 500 mg if delivered by cesarean section. All newborns were admitted to level 3 neonatal intensive care unit. Newborns were looked for any clinical feature of sepsis such as lethargy, hypotonia, fever, tachycardia, abdominal distension, retractions, grunting, increased aspirations, hypotension, delayed capillary refill, hypoglycemia, pallor, hepatomegaly, apnea, abnormal skin color, bradycardia, sclerema, shock, and features of disseminated intravascular coagulation.[1-4, 6] All newborns were subjected to a blood culture peripheral venous sample. Newborns were subjected to a septic screen (Total leucocyte count TLC, absolute neutrophil count-ANC, I: T ratio, C-reactive protein-CRP) at 24 h. All newborns were prospectively followed till their hospital stay. Baseline characteristics such as sex, maturity, weight, risk factors for sepsis, clinical features, and sepsis screen reports, UCBC and PVBC reports were recorded. UCBC as a diagnostic test was evaluated by using MedCalc online statistical calculator for sensitivity, specificity, positive and negative predictive values.

RESULTS

UCBC were collected from 45 (n) newborns. Table 1 shows baseline characteristics of the patients. A total of 11 (24.44%) patient had positive UCBC growth and 8 (17.8%) had positive PVBC. All positive culture reports were from the patient having clinical diagnosis of sepsis, and septic screen was positive in all these newborns.

A total of 6 out of 11 UCBC positive patients were venous blood culture positive with similar organisms in both the cultures. Two out of eight patients of PVBC positive patients had no growth in UCBC. UCBC has a sensitivity of 80% [95% confidence interval (CI): 44.43-96.89%], specificity of 91.43% [95% CI: 76.92-98.10%], positive predictive value of 72.73% [95% CI: 39.08-93.65], and a negative predictive value of 94.12% [95% CI: 80.29-99.11%] in diagnosis of neonatal sepsis in present study. Table 2 shows results of UCBC and PVBC. Table 3 shows comparison of organism growth in UCBC and PVBC.

DISCUSSION

Growth of microorganism in a PVBC sample is the gold standard for diagnosis of neonatal sepsis.[1-3, 6] Volume

Table 1: Baseline characteristics of patients

| Details                  | Group A, n=43 |
|--------------------------|--------------|
| Sex                      | F:M          |
| Weight in kg, mean (SD)  | 2.25 (0.685) |
| Maturity in weeks, mean (SD) | 34.5 (2.6)  |
| Presence of two or more risk factors (high risk) | 45 |
| Umbilical cord blood culture sent | 45 |

Prematurity (<35 completed weeks); premature rupture of membranes (>18 h); foul smelling liquor; maternal fever (>100.4°F); frequent vaginal examinations (>3); birth asphyxia, prolonged labor (>24 h); low-birth weight (<2.5 kg). SD – Standard deviation; F – Female; M – Male

Table 2: Result of umbilical cord blood culture and peripheral venous blood culture

| Culture result | UCBC (%) | PVBC (%) |
|----------------|----------|----------|
| Positive       | 11 (24.44) | 8 (17.8) |
| Negative       | 34 (75.56) | 37 (82.2) |
| Total (n)      | 45       | 45       |

PVBC – Peripheral venous blood culture; UCBC – Umbilical cord blood culture

Table 3: Microorganisms growth in culture

| Patient’s detail | Organism in UCBC* | Organism in PVBC** |
|------------------|-------------------|--------------------|
| Baby Kailash Bhupat (M) | Pseudomonas | Pseudomonas |
| Baby Badal (F) | Pseudomonas | Pseudomonas |
| Baby Sumitra Dinesh (F) | E. coli | - |
| Baby Prabha Bhupat (F) | Pseudomonas | - |
| Baby Geeta Mayghan (M) | Pseudomonas | - |
| Baby Deepa Mukesh (F) | Acinetobacter | - |
| Baby Kanchan Dinesh (F) | E. coli | E. coli |
| Baby Nurajahaa (M) | Acinetobacter | - |
| Baby Savita Laxman (M) | Klebsiella | Klebsiella |
| Baby Pushpa Kundan (M) | Pseudomonas | Pseudomonas |
| Baby Sapna Amit (M) | - | Pseudomonas |
| Baby Farhana Harun (F) | - | E. coli |
| Baby Joshua Jitu (F) | Acinetobacter | Acinetobacter |

*UCBC – Umbilical cord blood culture; **PVBC – Peripheral venous blood; E. Coli = Escherichia coli; F = Female; M = Male
of blood sample collected is important factor in blood culture positivity. A major problem of PVBC is difficulty in collecting adequate volume of blood.[5,6,9] Antibiotics administration before collecting blood sample is a common reason for no growth in PVBC.[5,6,9] Health care providers with increased skills are needed to perform venipuncture of a neonate, and these highly skilled providers must spare so much time to obtain a newborn blood sample.[5]

Collecting UCBC is studied years back by a few researchers.[11-18] In 1963, Pryles et al.[11] reported effect of chorioamniotic infection on newborns by using UCBC in 150 patients. In 1966, Albers and Tyler[12] studied umbilical cultures for diagnosis of neonatal sepsis. In 1981, Polin et al.[13] reported use of UCBC for diagnosis of neonatal sepsis by collecting 200 UCBC. In their study, Herson et al.[14] used blood collected from umbilical vein from placental surface from 81 newborns and concluded it to be an useful addition in newborn at-risk for sepsis.

In 2005, Hansen et al.[15] assessed paired results of cord blood and venous blood for complete blood counts for analysis in 113 newborns. The conclusion was cord blood could be safely substituted for infant blood in sepsis evaluations of asymptomatic term infants.

In 2006, Costakos et al.[16] has substituted conventional blood culture collection with umbilical cord blood sample as part of universal screening for early-onset sepsis based on maternal risk factors and reported about the process of collecting UCBC and showed the method is reliable and less painful.

In 2010, Fos et al.[17] had collected UCBCs of 30 newborns samples and concluded that UCBC represent a more easier and sensible way of diagnosis of neonatal sepsis.[17]

We analyzed samples of 45 newborns. Sample size of above-mentioned studies ranged from 30 to 319.[11-17] Studies by Herson et al., and Fos et al., closely resemble our study, which focused on perinatal risk factors of neonatal sepsis. Herson et al., had a sample size of 81 and Fos et al., had an effective sample size of 30 UCBCs.[14-17]

Diagnosis of sepsis was made based on positive PVBC. Chacko and Sohi[18] have shown sepsis rate of 20.6% in high-risk newborns and 0.5% of no risk newborns. In our study, 17.8% newborns had positive PVBC. Fos et al.[17] has shown a sepsis rate of 28% in high-risk newborns. Pryles et al.[11] have shown a sepsis rate of 31% in neonates with high risk of sepsis.

We had 24.44% high-risk newborns with positive UCBC (11 out of 45). Albers and Tyler had 9% (13 out of 319), and Polin et al., had 3% (6 out of 200) positive UCBC.[12-13] These studies were screening studies without any focus on risk factors. In a study of Pryles et al.[11] umbilical cord culture positive rate was 47% in high-risk newborns. Herson et al., in their study had UCBC positivity in 20% (7 out of 35) in high-risk newborns.[14] In a study by Fos et al.[17] 43% (13 out of 30) UCBC were positive in high risk for sepsis newborns.

Gram-negative organisms were predominant in both UCBC and PVBC, with Pseudomonas being most frequent followed by Acinetobacter, Escherichia coli, and Klebsiella. In the study by Fos et al.,[17] gram-positive and gram-negative organisms constituted 50% each. According to National neonatal perinatal database of India of 2002-03, organisms causing sepsis in intramural babies were Klebsiella (32.5%), Staphylococcus aureus (13.6%), E. coli (10.6), Pseudomonas (5.6%), and Acinetobacter (2.7%).[3,19] A study of Sundaram et al.[20] showed, nonfermenting gram-negative bacilli) found in 30% of cultures, with S. aureus (20%), Klebsiella (12%), Acinetobacter (5%), and Pseudomonas in (4%). In these studies, gram-negative organisms were prominent, but organism profiles were different from our study.

However, recent studies from India showed similar organism profile as in our study. A study by Bhat et al,[21] showed 90.8% organisms were gram-negative and commonest organism were Pseudomonas (32.2%), Klebsiella (31.2%), Acinetobacter (14.4), and E. coli (4.4). In a study by Chacko and Sohi[18] Pseudomonas was found in 60% culture positive sepsis, followed by Klebsiella (13%) S. aureus (13%), and E. coli (7%). Other study of Pais et al.,[22] suggested that commonest organism growth was of pseudomonas in early-onset sepsis (11.46%).

In summary, UCBC is comparable to peripheral venous blood in diagnosis of neonatal sepsis in high-risk newborns. Organisms grown in UCBC were comparable PVBC and organisms found in other studies. However, UCBC were negative in two patients in venous blood culture positive newborns.

CONCLUSIONS

Blood culture obtained from an umbilical cord sample is a good way to increase etiological diagnosis of bacterial sepsis in high-risk neonates as compared with PVBC. Organisms grown in umbilical cord blood samples are comparable with venous blood culture. It has certainly an additional value for diagnosis of neonatal sepsis.

REFERENCES

1. Dutta S, Kadam S, Saini SS, Bhakoo ON, Mathur NB. Writing group. Management of Neonatal Sepsis. National neonatology forum of India: Evidenced based clinical practice guidelines; 2010. p. 155-72.
2. Chawla D, Agarwal R. Rational approach to diagnosis of neonatal sepsis. J Neonatol 2006;20:4-7.
3. Deorari AK, Paul VK, Investigators of National neonatal perinatal database (NNPD). Report 2002-2003. NNPD Network. Jan, 2005. Available from: http://www.newbornwho.cc.org/pdf/nnpdreport2002-03.PDF [Last accessed on 2013 May 10].
4. Sivanandan S, Soraisham AS, Swarnam K. Choice and duration of antimicrobial therapy for neonatal sepsis and meningitis. Int J Pediatr 2011;2011;7:12150.
5. Polin RA, Committee on Fetus and Newborn. Management of neonates with suspected or proven early-onset bacterial sepsis. Pediatrics 2012;129:1006-15. Available from: http://pediatrics.aappublications.org/content/129/5/1006.full.html [Last accessed on 2013 May 10].
6. Saini SS, Dutta S, Ray P, Narang A. Short course versus 7-day course of intravenous antibiotics for probably neonatal septicemia: A pilot open-label randomized controlled trial. Indian Pediatr 2011;48:19-24.
7. Chowdhary G, Dutta S, Narang A. Randomised controlled trial of 7-Day vs. 14-Day antibiotics for neonatal sepsis. J Trop Pediatr 2006;52:427-32.
8. Brown DR, Kutler D, Rai B, Chan T, Cohen M. Bacterial concentration and blood volume required for a positive blood culture. J Perinatol 1995;15:157-9.
9. Neal PR, Kleiman MB, Reynolds JK, Allen SD, Lemons JA, Yu PL. Volume of blood submitted for culture from neonates. Clin Microbiol 1986;24:353-6.
10. Knudson RP, Alden ER. Neonatal heelstick blood culture. Pediatrics 1980;65:505-7.
11. Pryles CV, Steg LN, Nair S, Gellis SS, Tenney B. A controlled study of the influence on the newborn of prolonged premature rupture of the amniotic membranes and/or infection in the mother. Pediatrics 1963;31:608-22.
12. Tyler CW Jr, Albers WH. Obstetric factors related to bacteremia in the newborn infant. Am J Obstet Gynecol 1966;94:970-6.
13. Polin RJ, Knox I, Baumgart S, Campman E, Mennuti MT, Polin RA. Use of umbilical cord blood culture for detection of neonatal bacteremia. Obstet Gynecol 1981;57:233-7.
14. Herson VC, Block C, McLaughlin JC, Tetreault J, Eisenfeld LI, Krause PJ. Placental blood sampling: An aid to the diagnosis of neonatal sepsis. J Perinatol 1998;18:135-7.
15. Hansen A, Forbes P, Buck R. Potential substitution of cord blood for infant blood in neonatal sepsis evaluation. Biol Neonate 2005;88:12-8.
16. Costakos DT, Walden J, Rinzel MT, Dahlen L. Painless blood testing to prevent neonatal sepsis. WMJ 2009;108:321-2.
17. Bos NI, Gomis RV, Gomis CV, Rubio J, Justich P, Valera JC, et al. Blood culture from the umbilical vein in the diagnosis of neonatal sepsis. Internet J Pediatr Neonatol 2010;12:1. Available from: http://ispub.com/IJPN/12/1/4803 [Last accessed on 2013 May 10].
18. Chacko B, Sohi I. Early onset neonatal sepsis. Indian J Pediatr 2005;72:23-6.
19. Deorari A, Investigators of National neonatal perinatal database (NNPD). Changing pattern of bacteriologic profile in neonatal sepsis among intramural babies. J Neonatol 2006;20:1.
20. Sundaram V, Kumar P, Narang A. Bacterial profile of early versus late onset neonatal sepsis and their antibiotic susceptibility pattern between 1998 and 2004: An audit from a center in India. Ital J Pediatr 2011;37:32.
21. Puis M, Devi ES, Pai MV, Lewis L, Gorge A, Mayya S, et al. Neonatal sepsis, bacterial isolates and antibiotic susceptibility patterns among neonates. Nurs J India 2012;103:18-20.

How to cite this article: Kalathia MB, Shingala PA, Parmar PN, Parikh YN, Kalathia IM. Study of umbilical cord blood culture in diagnosis of neonatal sepsis. Obstet Gynecol 1981;57:233-7.

Source of Support: Nil, Conflict of Interest: None declared.