# CLINICAL EXPERIENCE OF CENTRAL VENOUS CATHETERIZATION IN NEWBORNS

## *YENİDOĞANLARDA SANTRAL VENÖZ KATETERİZASYON DENEYİMİ*

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**Gazi Medical Journal 2003; 14: 153-157**

*ABSTRACT*

***Purpose:*** *The use of central venous catheters (CVCs) is common practice in modern neonatal intensive care. We carried out a prospective study to investigate the success and complication rates of central venous catheterization in our neonatal intensive care unit.* ***Methods:*** *The results of all central venous catheter placements in our neonatal intensive care unit were documented and analyzed in the 1-year period between May 2003 and April 2004.* ***Results:*** *Forty-eight umbilical venous catheters (UVCs), 21 peripherally inserted central catheters (PICCs) and 4 central lines by a guide wire of the subclavian vein were inserted during the study period. The insertion success rates for UVCs and PICCs were 89.6% and 77.7%, respectively. The mean catheter survival was 13.7 ± 5.8 days with a maximum of 26 days for PICC lines and 6.9 ± 3.4 days with a maximum of 14 days for UVCs. Complications included bleeding at the puncture site in 1 case (4.8%), and transient bradycardia in 1 case (4.8%). One (4.8%) of the PICC lines became occluded during the period of use. Four (19.1%) PICCs were confirmed to be infected based on blood and line-tip cultures. Pericardial effusion developed in 1 infant due to the UVC.* ***Conclusion:*** *The use of central venous catheters is feasible and safe in neonates in our experience. However, we suggest that every patient with a central venous catheter be followed up cautiously in case of any complication related to the catheter.*

***Key Words:*** *Central Catheters, Umbilical Catheters, Catheter Complications, Neonatal Intensive Care (Unit).*

*ÖZET*

***Amaç:*** *Yenidoğanların yoğun bakımında santral venöz kateterizasyon yaygın olarak gerçekleştirilen bir uygulamadır. Bu prospektif çalışmada, yenidoğan yoğun bakım ünitemizde uygulanan santral venöz kateterizasyon işlemlerinin başarı ve komplikasyon oranlarını değerlendirmek amaçlanmıştır.* ***Yöntem:*** *Mayıs 2003- Nisan 2004 tarihleri arasında hastanemiz yenidoğan yoğun bakım ünitesinde izlenen hastalara takılan tüm santral venöz kateterler kaydedilmiş ve değerlendirilmiştir.* ***Bulgular:*** *Çalışma süresi boyunca toplam 48 umbilikal venöz kateterizasyon, 21 periferal santral venöz kateter ve 4 subklavian kateter takılmıştır. Umbilikal venöz kateterler için başarı oranı % 89.6, periferal santral venöz kateterler için % 77.7'dir. Ortalama kateter kullanım zamanı periferal santral venöz kateterler için 13.7 ± 5.8 gün olup en uzun kullanım süresi 26 gündür. Ortalama kateter kullanım zamanı, umbilikal venöz kateterler için 6.9 ± 3.4 gündür. Komplikasyon olarak bir hastada (% 4.8) girişim yerinden kanama, bir hastada geçici bradikardi (% 4.8) gelişti. Bir hastada periferal santral venöz kateter, kullanım sırasında tıkandı. Periferal santral venöz kateterlerden dördünün (% 19.1) kan kültürü ve kateter ucu kültürleri ile enfekte olduğu gösterildi. Bir hastada umbilikal venöz kateterizasyona bağlı perikardiyal efüzyon gelişti.* ***Sonuç:*** *Bizim uygulamalarımızda, yenidoğanlarda santral venöz kateterizasyon güvenli ve başarı bir işlemdir. Ancak, santral venöz kateteri olan her hasta olası komplikasyonlar açısından dikkatle izlenmelidir.*

***Anahtar Kelimeler:*** *Santral Kateterler, Umblikal Kateterler, Kateter Komplikasyonları, Yenidoğan, Yoğun Bakım Ünitesi.*

## INTRODUCTION

Central venous catheters (CVCs) are routinely used in neonatal intensive care units to provide intravenous access for prolonged intravenous therapy. Umbilical venous catheters

(UVCs), peripherally inserted central catheters (PICCs), central lines inserted over a guide wire at a puncture in a large superficial vein and surgically inserted central lines are the types of central venous lines used in neonatal care (1).

There are several reasons for using CV lines in newborns. They are mainly used to provide secure venous access for the administration of fluids and parenteral nutrition. They are also used to administer locally toxic solutions such as concentrated dextrose solutions. Larger bore lines can be used for other purposes, such as exchange transfusion and central venous pressure monitoring (1, 2).

Umbilical venous catheters have been used in both sick premature and sick term newborns for a long time and they are relatively easy to insert. Peripherally inserted central catheters are also widely used, especially in premature infants (1, 2).

Although CVCs have become technically easier to use and can be inserted at the cot side, they have been implicated as the cause of many immediate and long-term complications. Pneumothorax, pleural and pericardial infusions and vascular perforations due to direct tissue injury, intravascular thrombosis, embolism and catheter-related sepsis are well-known complications of CVCs (1-4).

Therefore, we carried out a prospective study to investigate the success and complication rates of central venous catheterization in our neonatal intensive care unit.

## MATERIALS AND METHODS

The results of all central venous catheter placements in our neonatal intensive care unit were documented and analyzed between May 2003 and April 2004. They were all performed in the open warmer in our unit. Routine monitoring included continuous electrocardiography and pulse oximetry. Midazolam, 0.05-0.1 mg/kg, or fentanyl, 1 mg/kg (1-hour infusion),. was administered intravenously before the procedure. CVCs were inserted according to the standard procedure by a staff neonatologist or fellows in neonatology. 27 G polyurethane PICCs (PremiCath 27G, Vygon, GmbH & Co., Germany) were used. Two types of polyurethane UVCs were used: Argyle (Sherwood Med Co., USA) and Vygon (USA) for umbilical venous catheterization. The length of the catheter required for correct placement was estimated from a measurement of the surface anatomy before insertion. After insertion, a plain radiograph was routinely taken to assess the position of the catheter before starting an infusion. The desired location is for the tip of the catheter to be just above the right diaphragm or is defined according to the vertebral bodies. Greenberg et al. (5) reported that UVCs at T8-9 level on chest X-ray were located at the right atrial/inferior vena cava junction by echocardiography. Ades et al. (6) showed that UVCs properly placed in the right atrial/inferior vena cava junction or in the inferior vena cava, as documented by echocardiography, were located at a wide range of vertebral bodies (T6-T11) on X-ray. If the position of the catheter tip could not be determined, contrast radiography was performed (Fig. 1). A 1-ml bolus of non-ionic, water-soluble contrast medium (Omnipaque, Nycomed Imaging, Norway) was injected into the catheter during radigraphic exposure. Standard parenteral nutrition solutions containing aminoacids, 10-20% glucose, and electrolytes were infused at constant rates and 12 IU heparin was added to the infusion solution daily to prevent thrombosis.

## RESULTS

Fifty-eight infants (79 catheters) were scheduled for either umbilical venous or percutaneous central venous catheterization during the study period. The median (and ranges)

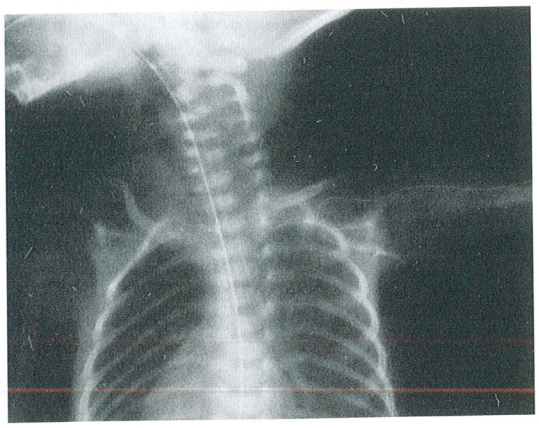

Fig. 1: Lineogram with contrast showing the malposition of the peripherally inserted central catheter.

of gestational age was 32 (26-41) weeks in UVC-inserted and 30 (26-39) weeks in PICC-inserted infants. The median (and ranges) birth weight was 1510 (908-3450) g in UVC-inserted and 1324 (908-3220) g in PICC-inserted infants. Neither a UVC nor a PICC could be inserted in 11 patients because of technical reasons. Forty-eight (89.6%) of the UVC attempts and 21 (77.7%) of the PICC attempts were successful. Four central lines were inserted over a guide wire of the subclavian vein. The clinical features of the infants are given in Table 1. Age and weight did not correlate with insertion success. Peripheral veins used for access included the basilic in 9 infants, cephalic in 2, and saphenous in 10. All babies had radiographs to confirm the position of the catheter tip. In 4 cases a contrast injection was required to determine the location. In 9 (8 UVC and 1 PICC) cases the catheter had to be repositioned according to the radiograph.

Mean catheter survival was 13.7 ± 5.8 days with a maximum of 26 days for PICC lines and 6.9 ± 3.4 days with a maximum of 14 days for UVCs.

Complications included bleeding at the puncture site in 1 case (4.8%), and transient bradycardia in another (4.8%). One (4.8%) of the PICC lines became occluded during the period of use and was removed. Four (19.1%) PICCs were confirmed to be infected based on blood and line-tip cultures before they completed the intended period of use. Catheter-related line sepsis was indicated by clinical findings in those infants and Staphylococcus epidermidis was cultered in 3 and Serratia in 1. They were treated with intravenous antibiotics. Pericardial effusion developed in 1 (2.3%) infant due to the UVC. He was diagnosed on the 3rd day following catheterization and after prompt intervention he survived. No infants died due to catheter-related complications.

## DISCUSSION

We found satisfactory success rates with all types of CVC insertion and the success of insertion did not appear to be related to the weight or gestational age of the babies. Liossis et al. (7) have reported that the success rate of PICC insertion was 74%, which was similar to our rate.

Appropriate placement and satisfactory location of the central venous catheter are the most important factors for avoiding potential mechanical complications. Left atrial placement is associated with a high rate of complications. Right atrial placement has also been shown to cause some severe complications (8). Therefore, the right atrial/inferior vena cava junction or thoracic inferior vena cava seem to be the ideal positions (4, 8).

In one of our infants the successful placement of an UVC in a satisfactory position was followed by pericardial effusion and tamponade. He was a term infant and the catheter was placed in the ideal position but this could not prevent pericardial effusion.

The demonstration of the catheter tip is not a problem with UVCs. However, the narrow caliber, poorly opaque PICC lines may be difficult to visualize using conventional radiography. A radiograph without contrast demonstrated the catheter tip in the majority of our cases, whereas a contrast injection was required in a few cases in which the line could not be seen. Reece et al. (9) prospectively assessed line visiability and found that 50% of patients required repeat radiography, with the use of intravenous contrast to clarify the position of the line. They concluded that intravenous contrast should be routinely used in the assessment of the PICC's position in the neonate. We suggest that intravenous contrast can be used in selected cases.

Catheter-related sepsis was found in 19% of the babies in which a PICC was inserted in the present study. The frequency of this complication has been reported to be 1-20% (10, 11). Although not all infants were of very low birth weight in the present study, the sepsis ratio was similar to that in previous studies. We suggest that the

Table-1: Clinical features of the infants with central venous catheters*.

| | UVC (n=43) | PICC (n=21) | P value |
|---|---|---|---|
| Indwelling time (days) | 6.9 ± 3.4 | 13.7 ± 5.8 | <0.001 |

* Values are mean ± SD.

complete aseptic precautions and strict nursing guidelines followed in our cases resulted in a reasonable catheter-related sepsis ratio. In those cases of suspected catheter-related sepsis treated by line removal in addition to the antibiotics the outcome was good. Chowdhary et al. (12) have reported that attempts to treat a line infection with the line in situ failed. Additionally, Benjamin et al. (13) have reported that the outcome for neonates in whom the central catheter was not removed within 24 hours of organism identification was significantly worse than it was for those whose catheters were removed promptly. Therefore efforts to prove and treat line sepsis without removing the catheter are unnecessary and we also suggest that the reinsertertion of a new catheter in such babies, as reinserting a new line, is simpler. No catheter-related sepsis was found in infants in the UVC group. Chien et al. (14) have also reported that the risk of nosocomial blood stream infection was highest for PICCs and lowest for UVCs. This might be due to the shorter indwelling time of those catheters compared to PICCs. The lower infection risk of umbilical venous catheters may also be related to their predominant use during the first week of life when infection risks are different and the high prevalence of antibiotic use during the same period.

Coagulase-negative Staphylococcus was the most frequent microorganism responsible for catheter-related sepsis in the present study. Our results confirm previous reports that coagulase-negative Staphylococcus and Candida were the major organisms associated with catheter-related nosocomial blood stream infection in the neonatal intensive care unit (15, 16). The lower incidence of Gram-negative infections with PICCs could be related to the higher incidence of coagulase-negative staphylococcal infection or might be because percutaneous CVCs could be inserted in the limbs at sites more distant to the diaper area than other catheters (14).

In conclusion, the use of central venous catheters is feasible and safe in neonates in our experience. However, we suggest that every patient with a central venous catheter should be followed up cautiously in case of any complication related to the catheter.

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**REFERENCES**

1. Menon G. Neonatal long lines. Arch Dis Child Fetal Neonatal Ed 2003; 88: F260-F262.
2. Hogan MJ. Neonatal vascular catheters and their complications. Radiol Clin North Am 1999; 37: 1109-1125.
3. Ainsworth SB, Furness J, Fenton AC. Randomized comparative trial between percutaneous longlines and peripheral cannulae in the delivery of parenteral nutrition. Acta Paeditr 2001; 90: 1016-1020.
4. Nadroo AM, Lin J, Green RS, Magid M, Holzman IR. Death as a complication of peripherally inserted central catheters in neonates. J Pediatr 2001; 138: 599-601.
5. Savani RC, Valentini RP, Mimouni F. Neonatal Radiology Casebook: pericardial effusion as a complication of umbilical venous catheterization. J Perinatol 1990; 10: 443-445.
6. Bjorklund LJ, Malmgren N, Lindroth M. Pulmonary complications of umbilical venous catheters. Pediatr Radiol 1995; 25: 149-152.
7. Liossis G, Bardin C, Papageorgiou A. Comparison of risks from percutaneous central venous catheters and peripheral lines in infants of extremely low birth weight: a cohort controlled study of infants ≤1000 g. J Matern Fetal Neonatal Med 2003; 13: 171-174.
8. Leipala J, Petaja J, Fellman V. Perforation complications of percutaneous central venous catheters in very low birthweight infants. J Paediatr Child Health 2001; 37: 168-171.
9. Reece A, Ubhi T, Craig AR, Newell SJ. Positioning of long lines:contrast versus plain radiography. Arch Dis Child Fetal Neonatal Ed 2001; 84: F129-F130.
10. Cairns PA, Wilson DC, McClure BG, Halliday HL, McReid M. Percutaneous central venous catheter use in the very low birth-weight neonate. Eur J Pediatr 1995; 154: 145-147.
11. Chathas MK, Paton JB, Fisher DE. Percutaneous central venous catheterization. Three years' experience in a neonatal intensive care unit. Am J Dis Child 1990; 144: 1246-1250.
12. Chowdhary SK, Parashar K, Buick RG, Gornall P, Corkery JJ. Central-venous access through the peripheral route in surgical neonates:an audit of 125 consecutive lines from a regional neonatal centre. Pediatr Surg Int 2001; 17: 433-435.
13. Benjamin DK, Miller W, Garges H, Benjamin DK, McKinney RE, Cotton M, Fisher RG, Alexander KA. Bacteremia, central catheters, and neonates: when to pull the line. Pediatrics 2001; 107: 1272-1276.

14. Chien LY, Macnab Y, Aziz K, Andrews W, McMillan DD, Lee SK, and The Canadian Neonatal Network. Variations in central venous catheter-related infection risks among Canadian neonatal intensive care units. Pediatr Infect Dis J 2002; 21: 505-511.
15. Schiff DE, Stonestreet BS. Central venous catheters in lowbirth weight infants: incidence of related complications. J Perinatol 1993; 13: 153-158.
16. Salzman BM, Isenberg HD, Shapiro JF, Lipsitz PJ, Rubin LG. A prospective study of the catheter hub as the portal of entry for microorganisms causing catheter-related sepsis in neonates. J Infect Dis 1993; 167: 487-490.