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Düşük Doğum Ağırlıklı Yenidoğanlarda Santral Olarak Yerleştirilen Santral Venöz Kateterlerin Retrospektif Analizi: 50 Olgu ile Deneyimlerimiz

Retrospective Analysis of Centrally Inserted Central Venous Catheters in Low Birth Weight Neonates: Our Experience with 50 Cases

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ÖZ

GİRİŞ ve AMAÇ: *Santral ven kateterlerin (SVK) kullanımı, çocuklarda uzun süreli sıvı tedavi sağlanmasına izin verir. Amacımız, SVK yerleştirilen düşük doğum ağırlıklı yenidoğan bebeklerin klinik özellikleri ve tedavi sonuçlarını sunmaktır.*

YÖNTEM ve GEREÇLER: *Bu retrospektif çalışma, düşük doğum ağırlıklı, ortalama yaşı 81.3 ± 55.3 gün olan 50 olgunun (37 kız, 13 erkek) tıbbi dosya ve bilgisayar kayıtlarından elde edilen veriler kullanılarak yapıldı. Olgular üçüncü basamak bakım merkezinin neonatoloji bölümünde tedavi edildi. Demografik, klinik ve hematolojik değişkenler arasındaki ilişki araştırıldı.*

BULGULAR: *Olgular düşük doğum ağırlıklı olup büyük çoğunluğunda komorbidite vardı (n = 46,% 92). Komplikasyonlar 14 olguda (% 28) kaydedildi ve 9 (% 18) olguda revizyon gerekli oldu. Kateter enfeksiyonu 18 (% 36) olguda saptandı.Takılan kateter ucu en sık olarak 5. (n = 12,% 24) ve 6. (n = 9,% 18) kosta seviyesinde olduğu saptandı. Enfeksiyon 15 (% 30) olguda kateterin çıkarılma nedeniydi. SVK'in uzun süre kullanıldığı (p = 0.027) olgularda ve trombosit sayısı belirgin olarak yüksek (p = 0.032) olgularda revizyon uygulama oranı anlamlı derecede yüksekti. Enfeksiyon nedeniyle çıkartılması gereken SVK'lı olgularda aktive parsiyel tromboplastin süresi belirgin olarak uzundu (p = 0.045).*

TARTIŞMA ve SONUÇ: *Düşük doğum ağırlıklı olgular genellikle komorbiditeye sahiptirler ve komplikasyonlara karşı hassastırlar. Bu olgulara uzun süreli sıvı tedavi gerekebilir ve SVK'ler ilaç uygulama ve parenteral nutrisyon için gerekli olabilir. Bu çalışmayla, SVK'ların düşük doğum ağırlıklı bebeklerde uzun süreli sıvı ve ilaç tedavi için güvenli ve pratik bir erişim yolu oluşturduğu bir kez daha gösterilmiştir.*

Anahtar Kelimeler: *yenidoğan, düşük doğum ağırlıklı, santral ven katateri, komplikasyon*

ABSTRACT

INTRODUCTION: *The use of centrally inserted central venous catheters (CICCs) allows maintenance of prolonged intravenous access in children. Our aim was to outline the characteristics of the low birth weight new-born population that received CICC and to present our therapeutic outcomes.*

METHODS: *This retrospective study was performed using data derived from the medical files of 50 infants (37 females, 13 males) aged 81.3±55.3 days. Patients were treated in the neonatology department of our tertiary care centre. Relationship between demographic, clinical and hematologic variables was investigated.*

RESULTS: *The vast majority of our patients had comorbidities (n=46, 92%). Complications were noted in 14 patients (28%) and revision was necessary in 9 (18%) cases. Catheter infection was evident in 18 patients (36%), while the tip of the catheter was most commonly detected at the levels of 5th (n=12, 24%) and 6th (n=9, 18%) costa. The reason for removal of the catheter was infection in only 15 (30%) of cases. The durability of CICC was significantly longer (p=0.027) and platelet count was notably higher (p=0.032) in patients that underwent revision intervention. In patients with infectious aetiology for removal of CICC, activated partial thromboplastin time was remarkably longer (p=0.045).*

DISCUSSION and CONCLUSION: *We suggest that CICCs constitute a reliable, safe and practical route of access for prolonged intravenous treatment in infants with low birthweight. Identification of patients who may require revision intervention and increased awareness on catheter infection may improve success rate and decrease the likelihood of complications and hazards.*

Keywords: *new-born, underweight, centrally inserted central catheter, complication*

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INTRODUCTION

Centrally inserted central venous catheters (CICCs) were introduced in the 1970s and modifications like the Dacron cuff by Hickman in 1979 aided in the improvement of their durability (1). The CICCs are commonly utilized to establish a prolonged route of intravenous (IV) access in both acute or home care settings. It provides a reliable vascular access for total parenteral nutrition (TPN) in neonates (2-4). The percutaneous silicone venous catheter placement is the preferred route of small-diameter central venous access for particularly preterm infants (2).

This method was initially described by Shaw, who used scalp veins to pass the catheter to the right atrium (3). After reaching the target position, the position of the catheter was controlled radiographically by means of radio-opaque contrast injection (4). Central venous catheterization aids administration of total parenteral nutrition in sick very low birthweight babies and it avoids the necessity for repeated insertion of cannulas into peripheral veins. Thereby, it also reduces the incidence of scarring linked with prolonged infusion of hypertonic solutions through small blood vessels (5). The possibility of malfunction and displacement have been reported in CICCs (6). However, anchoring by suture may overcome this risk and compared to peripherally inserted central catheters (PICCs), CICCs remain in place for a longer time. Moreover, severe complications were rarely encountered with CICCs. In spite of the removal possibility due to phlebitis or infiltration, CICCs stay in place for a longer time (6).

The CICCs have been utilized for providing intravenous access in order to introduce prolonged courses of antibiotics particularly during exacerbations of pulmonary infections in paediatric cystic fibrosis patients. The use of CICCs was popularized owing to the ease of insertion and low rate of complications compared with other surgically placed central lines. These CICCs are made of biocompatible materials such as polyurethane or silicone. Insertion is a simple process which can be performed through antecubital veins; besides, other vessels such as saphenous, axillary or scalp veins (4,5).

Complications linked with insertion of CICCs are not very common, but serious hazards such as bleeding, tendon or nerve damage, cardiac arrhythmias, chest pain, pleural effusion, pericarditis, catheter malposition, and embolism may be encountered (4). Furthermore, malposition of catheter tip may be associated with hazardous outcomes such as cardiac tamponade from catheters with tips in the right atrium, right ventricle, and superior vena cava, myocardial infiltration in the right atrium, ascites (if the tip is in inferior vena cava), erosion into pulmonary vessels, hypoglycaemia (if the tip is in shoulder and abdominal wall), diaphragmatic paralysis, paraplegia and venous sinus thrombosis (if the tip is in jugular vein) (4).

We examined the use of CICC in the paediatrics department of a university hospital. Our purpose was to outline the characteristics of the low birth weight new-born population that received CICC, as well as documentation of clinical features, complications, need for revision, reason for removal, microbiological isolation and laboratory data. Hopefully, our results may aid in the follow-up of patients with CICC insertion by identification of risk factors and increase awareness for possible complications of this procedure.

METHODS

Study design

This retrospective study was carried out using data derived from the medical records of 50 neonates born with a birth weight between 1700 g to 3000 g. Our series consisted of 37 females (74%) and 13 males (26%) with an average age of 81.3±55.3 days (range: 8 to 203). All cases underwent CICC procedure in the neonatal intensive care unit of the paediatrics department of our university hospital. Since attending physicians were familiar with percutaneous route, this approach was routinely preferred in all cases. The approval of the local institutional review board (no/date) has been obtained prior to the study.

Intervention

CICCs were inserted at the operation theater by appropriately trained physicians using the modified Seldinger technique into either the subclavian or internal jugular vein. Catheters inserted into the

internal jugular vein were inserted under real-time ultrasound guidance. All catheters were sutured into place, and all patients received a chest X-ray to confirm the appropriate placement. Catheters were routinely flushed with heparin unless a heparin allergy existed.

Outcome parameters

The neonatal database was examined for all infants followed-up between 2015 and 2016. Fifty consecutive catheterizations were reviewed in terms of baseline descriptives (age, body weight, height, gender, body-mass index), comorbidities, site of CICC procedure, number of interventions to provide CICC, level of CICC determined by plain radiographs and the duration of CICCs. White blood cell count, haemoglobin, haematocrit, platelet count, prothrombin time, activated partial thromboplastin time and international normalized ratio were recorded from the medical files. Remarkably, complications, need for revision, presence of catheter infection, reason for removal, microorganismal growth from the tip and the position of the catheter tip determined on posteroanterior plain radiographs were other variables under investigation.

Statistical analysis

Analysis of our data was analysed using IBM Statistical Package for Social Sciences Statistics 20 software (SPSS Inc., Chicago, IL, USA). Normal distribution of variables was tested with Kolmogorov Smirnov test. Parametric and non-parametric tests were employed for variables with and without normal distribution, respectively. Comparison of 2 independent groups was made with Independent Samples T test and Mann Whitney U tests. Categorical variables were assessed with Pearson Chi Square test. Quantitative variables were expressed as mean± standard deviation, or median-interquartile range. Confidence interval was 95% and level of significance was set at p value less than 0.05.

RESULTS

An overview of baseline descriptive, clinical data and hematologic parameters are presented in Table 1. The vast majority of our patients (n=48, 96%) were underweight (BMI<18.5) and comorbidities were diagnosed in 46 cases (92%). Complications were noted in 14 patients (28%) and revision was necessary in 9 (18%) cases. Catheter infection was evident in 18 patients, while the tip of the catheter was most commonly detected at the levels of 5th (n=12, 24%) and 6th (n=9, 18%) costa. The reason for removal of the catheter was infection in only 15 (30%) of cases in this series (Table 2).

Table 1. Baseline descriptives, clinical data and laboratory results in our series.

Variable	Average (mean±standard deviation)	Range
Age (days)	81.3±55.3	8-203
Weight (grams)	2554.4±432.5	1700-3000
Height (cm)	46.9±6.4	31-58
BMI (kg/m^2)	11.99±3.04	7.60-23.36
No. of interventions	2.0±1.7	1-10
Level of the catheter	5.3±0.9	4-8
WBC count (X10^3/µL)	13.06±7.35	0.8-47.7
Hemoglobin (g/dL)	11.61±2.30	7.9-17.1
Haematocrit (%)	41.39±46.30	23.8-359.0
Platelet count (X10^3/µL)	248.53±150.31	46.0-651.9
Prothrombin time (seconds)	17.99±16.32	11.6-120.0
aPTT (seconds)	52.35±40.68	14.3-160.0
INR	1.22±0.39	0.9-3.3

BMI: body-mass index; WBC: white blood cell; aPTT: activated partial thromboplastin time; INR: international normalized ratio

Table 2. Overview of demographic and clinical data in our series (n=50).		
Variable		**n (%)**
Gender	Female	37 (74)
	Male	13 (26)
Body-mass index	Underweight (<18.5)	48 (96)
	Normal (18.5-25)	2 (4)
Comorbidity	No	4 (8)
	Yes	46 (92)
Site of intervention	Right	24 (48)
	Left	26 (52)
Complication	No	36 (72)
	Yes	14 (28)
Revision	No	41 (82)
	Yes	9 (18)
Catheter infection	No	32 (64)
	Yes	18 (36)
Microorganism isolation	No	33 (66)
	Yes	17 (34)
Level of catheter on plain radiograph	Unknown	5 (10)
	3^{rd} costa	2 (4)
	3^{rd}-4^{th} costa	1 (2)
	4^{th} costa	6 (12)
	4^{th}-5^{th} costa	8 (16)
	5^{th} costa	12 (24)
	5^{th}-6^{th} costa	4 (8)
	6^{th} costa	9 (18)
	6^{th}-7^{th} costa	1 (2)
	7^{th} costa	2 (4)
Reason for removal of catheter	Infection	15 (30)
	Other	35 (70)

The durability of CICC was significantly longer (p=0.027) and platelet count was notably higher (p=0.032) in patients that underwent revision intervention (Table 3). In terms of other baseline, clinical and laboratory parameters, there was no difference between patients that required and did not require revision intervention (Tables 3 and 4).

In patients with infectious aetiology for removal of CICC, activated partial thromboplastin time was remarkably longer (p=0.045) (Table 5). As it would be expected, microorganism isolation was more common in patients with an indication of infection for removal of CICC (p<0.001) (Table 6).

Table 3. Comparison of baseline descriptives and clinical variables with respect to the need for revision of CICC intervention

Variable	Revision	n	Average	p-value
Age (days)	No	41	77.4±32.8§	0.287
	Yes	9	99.2±65.9§	
Durability of CICC (days)	No	41	14,6±7.0§	0.027*
	Yes	9	20,9±9.3§	
White blood cell count (X10^3/µL)	No	41	12.89±5.69§	0.732
	Yes	9	13.83±12.96§	
Hemoglobin (g/dL)	No	41	11.72±2.44§	0.487
	Yes	9	11.13±1.53§	
Platelet count (X10^3/µL)	No	41	227.34±142.10§	0.032*
	Yes	9	345.10±156.94§	
Body-mass index (kg/m^2)	No	41	11.20-2.68§	0.426
	Yes	9	10.96-4.01ǂ	
Level of catheter on plain radiograph	No	41	5.0-1.0ǂ	0.106
	Yes	9	5.5-1.0ǂ	
Haematocrit (%)	No	41	34.30-10.70ǂ	0.622
	Yes	9	31.70-8.97ǂ	
Prothrombin time (seconds)	No	37	14.30-3.70ǂ	0.273
	Yes	9	15.00-2.60ǂ	
Activated partial thromboplastin time (seconds)	No	37	37.40-24.40ǂ	0.542
	Yes	9	37.70-17.45ǂ	
International normalized ratio	No	37	1.16-0.21ǂ	0.353
	Yes	9	1.18-0.15ǂ	

CICC: centrally inserted central catheter, §: expressed as mean±standard deviation; ǂ: expressed as median-interquartile range

Table 4. Comparison of baseline descriptives and clinical variables with respect to the need for revision of CICC intervention

Variable		Revision		p-value
		No	Yes	
Gender	Female	31 (75.6%)	6 (66.7%)	0.580
	Male	10 (24.4%)	3 (33.3%)	
Body-mass index	<18.5	39 (95.1%)	9 (100%)	0.499
	18.5-25	2 (4.9%)	0	
Comorbidity	No	4 (9.8%)	0	0.329
	Yes	37 (90.2%)	9 (100%)	
Site of intervention	Right	20 (48.8%)	4 (44.4%)	0.814
	Left	21 (51.2%)	5 (55.6%)	
Complication	No	31 (75.6%)	5 (55.6%)	0.225
	Yes	10 (24.4%)	4 (44.4%)	
Catheter infection	No	27 (65.9%)	5 (55.6%)	0.560
	Yes	14 (34.1%)	4 (44.4%)	
Microorganism isolation	No	28 (68.3%)	5 (55.6%)	0.465
	Yes	13 (31.7%)	4 (44.4%)	
Level of CICC on plain radiograph	Unknown	4 (9.8%)	1 (11.1%)	0.786
	3rd costa	2 (4.9%)	0	
	3rd-4th costa	1 (2.4%)	0	
	4th costa	5 (12.2%)	1 (11.1%)	
	4th-5th costa	5 (12.2%)	3 (33.3%)	
	5th costa	10 (24.4%)	2 (22.2%)	
	5th-6th costa	4 (9.8%)	0	
	6th costa	8 (19.5%)	1 (11.1%)	
	6th-7th costa	1 (2.4%)	0	
	7th costa	1 (2.4%)	1 (11.1%)	
Reason for removal of CICC	Infection	12 (29.3%)	3 (33.3%)	0.810
	Other	29 (70.7%)	6 (66.7%)	

CICC: centrally inserted central catheter

Table 5. Comparison of demographic and clinical parameters in patients who underwent removal of CICCs due to infectious and other etiologies

Variable	Reason for removal of CICC	n	Average	p-value
Age (days)	Infection	15	67.9±48.7§	0.265
	Other	35	87.1±57.5§	
Duration of CICC (days)	Infection	15	16.1±5.3§	0.818
	Other	35	15.6±8.7§	
White blood cell count (X10^3/µL)	Infection	15	12.10±7.33§	0.549
	Other	35	13.48±7.43§	
Hemoglobin (g/dL)	Infection	15	12.05±2.51§	0.386
	Other	35	11.43±2.22§	
Platelet count (X10^3/µL)	Infection	15	218.77±121.59§	0.365
	Other	35	261.29±160.98§	
Body mass index (kg/m^2)	Infection	15	10.80-1.61ǂ	0.368
	Other	35	11.40-3.28ǂ	
No. of interventions	Infection	15	1.0-1.0ǂ	0.580
	Other	35	2.0-1.0ǂ	
Level of CICC on plain radiograph	Infection	15	5.0-0.0ǂ	0.527
	Other	35	5.0-1.0ǂ	
Haematocrit (%)	Infection	15	37.50-10.70ǂ	0.290
	Other	35	32.50-9.60ǂ	
Prothrombin time (seconds)	Infection	15	14.40-1.30ǂ	0.879
	Other	35	14.40-2.70ǂ	
Activated partial thromboplastin time (seconds)	Infection	15	35.20-5.60ǂ	0.045*
	Other	35	41.00-26.60ǂ	
International normalized ratio	Infection	15	1.19-0.14ǂ	0.201
	Other	35	1.15-0.24ǂ	

CICC: centrally inserted central catheter; §: expressed as mean±standard deviation; ǂ: expressed as median-interquartile range

Table 6. Comparison of baseline descriptives and clinical variables with respect to the reason for removal of CICC

Variable		Etiology for removal of CICC		p-value
		Infection (n=15)	Other (n=35)	
Gender	Female	10 (66.7%)	27 (77.1%)	0.439
	Male	5 (33.3%)	8 (22.9%)	
Body-mass index	<18.5	15 (100%)	33 (94.3%)	0.345
	18.5-25	0	2 (5.7%)	
Comorbidity	No	1 (6.7%)	3 (8.6%)	0.820
	Yes	14 (93.3%)	32 (91.4%)	
Site of intervention	Right	6 (40%)	18 (51.4%)	0.459
	Left	9 (60%)	17 (48.6%)	
Complication	No	13 (86.7%)	23 (65.7%)	0.131
	Yes	2 (13.3%)	12 (34.3%)	
Microorganism isolation	No	1 (6.7%)	32 (91.4%)	<0.001*
	Yes	14 (93.3%)	3 (8.6%)	
Level of CICC on plain radiograph	Unknown	1 (6.7%)	4 (11.4%)	0.334
	3rd costa	0	2 (5.7%)	
	3rd-4th costa	1 (6.7%)	0	
	4th costa	1 (6.7%)	5 (14.3%)	
	4th-5th costa	2 (13.3%)	6 (17.1%)	
	5th costa	3 (20%)	9 (25.7%)	
	5th-6th costa	1 (6.7%)	3 (8.6%)	
	6th costa	5 (33.3%)	4 (11.4%)	
	6th-7th costa	1 (6.7%)	0	
	7th costa	0	2 (5.7%)	

CICC: centrally inserted central catheter

DISCUSSION

Central venous access is frequently used in infants and children in various conditions. Even CICCs have been reported to be safe with low complication rates, we need to be aware of possible complications and drawbacks of this procedure (4). Septicaemia and pleural effusions have been described as the most important complications of CICCs (4,5). In case septicaemia is evident, the catheter may not be necessarily the source of infection.

Kulkarni et al. implied that there was an increased risk of infection, non-infectious complication, and complication-related device removal among patients with CIEVC compared with those with totally implantable ports albeit with some caveats. The reported risk of infection varied substantially between individual studies, and this remained the case irrespective of study type and population (1).

Location of the catheter tips have been attempted with the use of radio-opaque catheters and plain radiography (4). Chaturvedi et al. reported that central venous catheterization using single orifice catheter through arm veins in paediatric patients is easy to perform, but the proper catheter tip placement is highly unreliable, particularly in younger children 1 to 5 years of age (9). In addition to appropriate positioning of CICCs, keeping the records appropriately is crucial for all intravascular catheters (4). Percutaneously inserted central venous catheters are regarded as lifesaving in providing nutrition to small neonates. The use of percutaneously inserted central venous catheters is safe, in a unit where strict management guidelines are followed, including the demonstration of catheter tip position by contrast radiography (4,5).

CICCs have been used by various pediatric subspecialties, and treatment was completed in two thirds of CICCs inserted with low rates of phlebitis and catheter-linked sepsis. Complications associated with CICC use outside were fewer than that in hospital setting and this difference was attributed to the fact that hospitalized children are typically sicker with an increased risk for nosocomial infections and exposure to multiple medications, which lead to higher incidence of thrombophlebitis. The increased occlusion rate in smaller lumen did not remarkably decrease the rate of completion of therapy in infants compared with older children. Neither any complications were associated with catheter insertion, nor risks related with placement of CICCs brought about significant risks for the patient. Catheter-associated sepsis necessitates removal of the catheter and initiation of appropriate antibiotic therapy. The incidence of infections was higher with CICCs used in the hospital setting and with TPN administration. Even though no serious complications were noted with removal of the catheters, difficulty may be observed owing to the fibrin deposition around the catheter (6). It has been reported that CICCs are safer for critically ill patients than either PICCs, since both of these have a higher rate of complications due to phlebitis and inflammation (6).

Cruzeiro et al. suggested a success rate of 81.9% at the initial attempt, while this rate was increased to 100% with the inclusion of the second site. Perioperative complications included hematomas and arterial punctures. During the time, the catheter was maintained in place, mechanical and infectious complications were noted. These complications were responsible for the removal of the catheter. On the other hand, in spite of the high complication rates; there were no catheter-related deaths. Interestingly, age, gender, type of catheter and primary diagnosis were not associated with complications. Knowledge of anatomy and familiarity with the technique highly increase the catheterization success rate, with few surgical complications. A better nursing care and increased experience for CICCs will improve the quality of paediatric medical care. Contemporarily, CICC constitutes the preferred method in paediatric patients (8).

In a previous publication, it was recommended that the choice of central venous catheter size must be based not only on the primary disease, but also on the child's age, weight, and height. Insertion of central venous catheters larger than 6F in children < 1 year of age, < 10 kg in weight, or < 75 cm in height, was linked with a higher rate of

complications (9). Sheridan et al. found that there was no difference in rates of infectious or mechanical complication between younger and older children. If closely supervised by an experienced surgeon, a low rate of infection as well as decreased acute mechanical complications and deep venous thrombosis are supposed to accompany central venous cannulation of critically ill children (10).

Our results yielded that CICCs are safe modes of intravenous access in neonates with low birth weight with acceptable rates of complication. Close monitoring is necessary for infectious and non-infectious reasons that may necessitate removal of the catheter. Clinical and laboratory data must be integratively assessed to for early diagnosis and effective treatment of possible hazardous outcomes.

Similar to our results, Johnson et al. reported that central venous catheterization in children is a relatively safe procedure, with only a 3.2% complication rate and no mortality (12). The relatively high rate of complications in our series may be linked with comorbidities and low birth weight. It was reported that the dwell time was longer in patients undergoing PICC compared to those who received CICC (13).

In relevant literature, it is postulated that CICCs could be readily performed in children of all ages with an acceptable degree of risk. Since the highest risk factor was the number of attempts at catheter insertion, increased experience and close supervision are crucial for achievement of acceptable results as well as minimization of complications. Infectious complications were found to be independent of the venous access site or the duration of catheterization (14). The cumulative complication rates in critically ill patients have been reported to be lower with CICC than PICCs (13).

Multiple factors must be considered during determination of of the route of central venous access. The ease of insertion and relatively low rate of insertion-related complications such as venous thrombosis must be taken into account. CICCs have been reported to be safer than PICCs in terms of risk for thrombosis (13). Since neonates and paediatric patient group deserves special care and attention, this point should be remembered during selection of the mode of catheterization. Our results are in conjunction with the report by Giuffrida et al. indicating that CICCs must be priorly preferred by carefully trained personnel who adhere to protocols consistently in order to achieve low rates of complication and morbidity (6).

Some limitations of the current study must be remembered: Retrospective design, small sample size, information restricted to the experience of a single institution as well as the impacts of environmental, social and ethnic factors must be taken into account during extrapolation of our results to larger populations.

CONCLUSION

Neonates with low birth may commonly have comorbidities and they are vulnerable for complications. These cases may require prolonged intravenous treatment and CICCs may be crucial for administration of medications and nutrients. Results of the present study demonstrated that CICCs constitute a reliable, safe and practical route of access for prolonged intravenous treatment in infants with low birthweight. Identification of patients who may require revision intervention for CICC and increased awareness on infection during use of CICC may increase therapeutic success and aid in elimination of complications and hazards. Multidisciplinary approach, increased experience, close monitorization and well-established guidelines are important aspects of medical care in neonates that receive prolonged intravenous treatment via CICCs. Rapid evaluation must be carried out for any unexplained conditions seen in the follow-up period after the procedure.

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