Acta Pædiatrica ISSN 0803–5253

TECHNICAL NOTE

A new technique for transumbilical insertion of central venous silicone catheters in newborn infants

D Haumont (Dominique_Haumont@stpierre-bru.be), V Gouder de Beauregard, I Van Herreweghe, G Delanghe, R Ciardelli, E Haelterman

Department of Neonatology and Paediatrics, Saint-Pierre University Hospital, Free University of Brussels, Belgium

Keywords
Central venous catheter, Umbilical catheter, Parenteral nutrition, Preterm-neonate

Correspondence
D Haumont, Department of Neonatology, Saint-Pierre University Hospital, Rue Haute, 322 B 1000 Brussels, Belgium.
Tel: + 32 2 5354226 |
Fax: + 32 2 5354563 |
Email: Dominique_Haumont@stpierre-bru.be

Received
4 October 2007; revised 11 January 2008; accepted 17 March 2008.

DOI:10.1111/j.1651-2227.2008.00786.x

Abstract

Aim: A new technique allowing placement of umbilical silicone venous catheters (USVC) is described and compared with percutaneous silicone venous catheters (PSVC).

Methods: Data were retrospectively recorded for 198 infants with USVC and 141 infants with PSVC.

Results: Overall rate of complications was low and comparable in both groups: thrombosis 1.2%, catheter-related sepsis 3.5% and mechanical obstruction 5%.

Conclusion: A new device allows safe introduction of silicone catheters into the umbilical vein.

The percutaneous silicone venous catheter (PSVC) is the preferred small-diameter central venous access in preterm infants (1). The umbilical vein is also a commonly used and easily accessible central venous route. However, because of a significant incidence of thrombosis, the polyurethane or polyvinyl chloride umbilical catheters are not suitable for long-term use (2,3). Silicone catheters lack stiffness for direct umbilical insertion. Therefore, we designed a new device for the introduction of the silicone catheter into the umbilical vein. The concept is shown in Figure 1 (ref.2184.01, Vygon). A rigid introducer serves as guide for advancing the silicone catheter into the umbilical vein. The umbilical silicone venous catheter (USVC) is inserted under classical conditions of sterile umbilical catheterisation. The silicone catheter and the easy-lock connection system are flushed with saline. One of the three introducers is chosen according to the required catheter insertion distance and flushed with saline too. The silicone catheter is inserted and pushed forward into the introducer 1–2 mm ahead of its distal end. A haemostat forceps is gently clamped at the proximal end of the introducer and will stop the catheter from moving. The introducer with the silicone catheter in his lumen is now inserted and advanced into the umbilical vein. The haemostat forceps is removed. After the introducer is advanced the appropriate distance, the silicone catheter is disconnected from the easy-lock infusion system. The introducer is carefully withdrawn and the catheter maintained in place by pushing it forward with a nontoothed forceps, similar to the percutaneous insertion. The silicone catheter is connected again with the infusion system and the tip position adjusted if needed. The position of the silicone catheter is verified by X-rays. If the catheter tip is not in the correct position (i.e. in the portal vein), it is promptly removed and the percutaneous route is used.

The catheter position is documented again 1 or 2 days later by echocardiography and eventually adjusted. Indeed, X-rays alone can be misleading for evaluation of catheter placement (4). Echocardiography is repeated 1 or 2 days before removal to exclude thrombosis. The patients with an umbilical line undergo abdominal echography before discharge in order to verify the portal and deep venous circulation.

All newborn infants admitted in the NICU of Saint-Pierre University Hospital between January 2002 and December 2005 and who underwent central silicone catheterisation were included in this study. Data on catheter complications were retrospectively abstracted from patient records. The silicone catheters were preferentially inserted by umbilical route during the first 2 days of life using the technique described above. The percutaneous route was used if the attending physician was not familiar with the USVC technique, if the umbilical vein was not accessible anymore or if the USVC was incorrectly positioned (i.e. portal vein). The 339 patients were divided into four groups: those who had one catheter, whether transumbilical (group USVC, $n = 161$) or percutaneous (group PSVC, $n = 125$); those who had more than one catheter, an USVC followed by one or more PSVCs (group USVC–PSVC, $n = 37$) and those who had several PSVCs (group PSVC–PSVC, $n = 16$).

We used χ^2 test or Fisher's exact test to compare proportions. For numerical variables with a Gaussian distribution, comparisons between groups were performed using the Student's *t*-test. For those with a non-Gaussian distribution we used the Mann–Whitney *U*-test. For comparing rates of catheter related sepsis per 1000 catheter days, we used exact probabilities based on the binomial distributions.

Patients who underwent USVC placement had birth weight ranging from 570 gm up to 3800 gm. Most of the

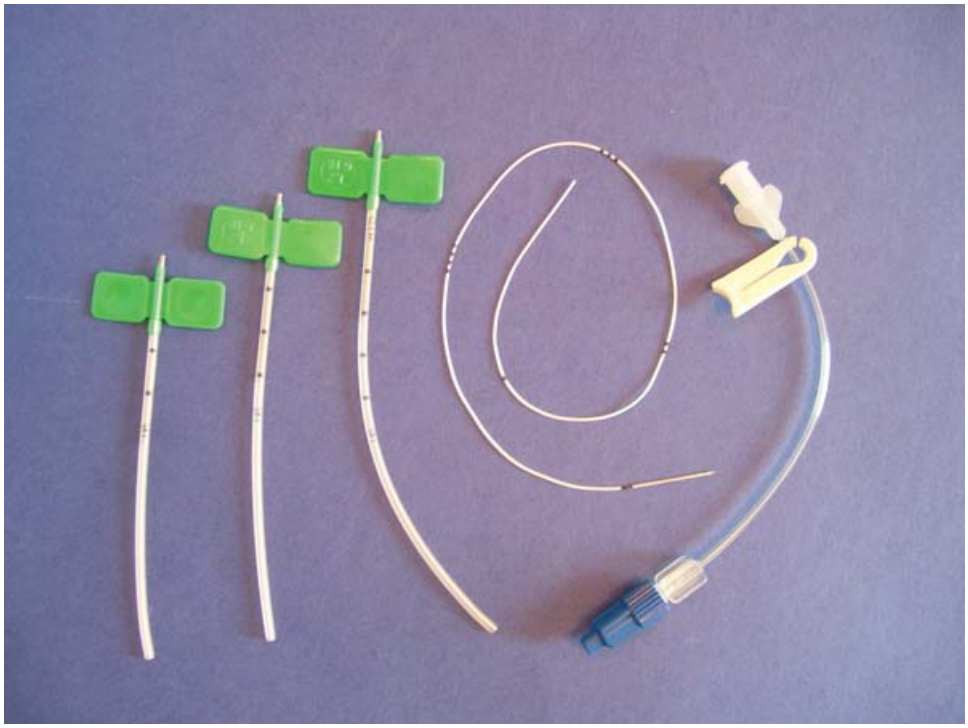

Figure 1 The USVC introducers (8.9 and 11 cm), the silicone catheter and the easy-lock connection.

Table 1 Clinical characteristics and catheter use of study infants

	One catheter		Several catheters	
	USVC n = 161	PSVC n = 125	USVC + PSVC n = 37	PSVC + PSVC n = 16
	Median (min–max) or N° (%)			
Birthweight (g)	1600 (700–3800)	1640 (760–3630)	1330 (570–2450)	1175 (740–3500)
Gestational age (weeks)	32 (25–41)	32 (26–41)	29 (25–34)	28 (24–38)
Catheter inserted on first day of life	132 (82.0%)	68 (54.4%)**	35 (94.6%)	13 (81.2%)
Number of catheters				
2	–	–	32 (86.5%)	14 (87.5%)
3–4	–	–	5 (13.5%)	2 (12.5%)
Duration of catheterization (days)				
Catheter 1	20 (2–48)	19 (3–62)	12 (1–43)	19 (1–42)
Catheter 2–4	–	–	21 (5–77)	22 (4–54)
Elective withdrawal	156 (96.9%)	116 (92.8%)	21 (56.8%)	6 (37.5%)

**$p < 0.01$ for comparison of PSVC (one catheter) with USVC (one catheter).

USVCs were placed at birth, significantly earlier than the PSVCs (Table 1). A vast majority, 286 out of the 339 infants had one central venous line lasting their whole hospital stay. The frequencies of catheter complications are provided stratified by catheter rank (Table 2). None of the classically important catheter complications were significantly different among groups. The small group PSVC + PSVC showed more mechanical obstruction ($p < 0.01$).

This study is the first evaluation of long-term transumbilical venous access with silicone catheters in a large number of patients. Former reports examined a very limited number of cases and did not describe a specific device (5,6). This study is neither prospective nor randomised but describes a new technique that might have substantial advantages in the intravascular access problems of newborn and especially preterm infants. Our data demonstrate the feasibility to place USVC in all ranges of birth weight.

Thrombosis occurred in four of the patients of the USVC group and not in the PSVC group. In 3 patients the routine echocardiography showed small asymptomatic thrombi at the catheter tip. They disappeared after thrombolytic treatment. One severe growth retarded patient showed partial portal vein thrombosis and portal hypertension diagnosed at the age of 3 months on abdominal echography. The patient

Table 2 Catheter complications

	One catheter		Several catheters	
	USVC n = 161	PSVC n = 125	USVC + PSVC n = 37	PSVC + PSVC n = 16
	N° (%) or rate per 1000 catheter days			
Thrombosis				
First catheter	3 (1.9%)	0 (0.0%)	1 (2.7%)	0 (0.0%)
Next catheter(s)	–	–	0 (0.0%)	0 (0.0%)
Mechanical obstruction				
First catheter	0 (0.0%)	1 (0.8%)	6 (16.2%)	9 (56.3%)**
Next catheter(s)	–	–	3 (8.1%)	0 (0.0%)
Catheter-related sepsis				
First catheter	1 (0.6%)	3 (2.4%)	4 (10.8%)	2 (12.5%)
Per 1000 catheter days	0.31	1.16	7.60	6.99
Next catheter(s)	–	–	0 (0.0%)	2 (12.5%)
Per 1000 catheter days	–	–	0.00	5.09
Probably related catheter sepsis				
First catheter	1 (0.6%)	5 (4.0%)	7 (18.9%)	0 (0.0%)
Per 1000 catheter days	0.31	1.94	13.31	0.00
Next catheter(s)	–	–	2 (5.4%)	0 (0.0%)
Per 1000 catheter days	–	–	2.13	0.00

**$p < 0.01$ for comparison of PSVC + PSVC with USVC + PSVC.

completely recovered in follow-up. In our unit no heparin is routinely used for catheter maintenance. In a recent randomised controlled trial Shah et al. have shown that heparin infusion prolonged the duration of the peripherally inserted central venous catheter usability (7). This should be evaluated in the USVCs in further studies. No severe side effect like pericardial effusion or tamponade was observed in our series. Risk of malposition of the USVC in the portal vein is comparable to any venous umbilical catheterisation. Comparative data of venous catheters in published studies report absence of complications in 51% to 82% of the patients (2,8–12). In this study we observed no complications in 88% of the patients.

In conclusion, we described the transumbilical use of a small-diameter silicone venous catheter. A specific introducer is needed to achieve placement. Indications for USVC placement are similar to PSVC. Complications in this study are comparable for USVC and PSVC. The advantages of USVC are an easy venous access, a sparing effect on peripheral veins and the baby's comfort. Further studies are needed to evaluate the use of USVC.

References

1. Ainsworth SB, Clerihew L, McGuire W. Percutaneous central venous catheters versus peripheral cannulae for delivery of parenteral nutrition in neonates. *Cochrane Database Syst Rev* 2007; 18(3): CD004219. Review.
2. Roy M, Turner-Gomes S, Gill G, Way C, Mernagh J, Schmidt B. Accuracy of Doppler echocardiography for the diagnosis of thrombosis associated with umbilical venous catheters. *J Pediatr* 2002; 140: 131–4.
3. Schmidt B, Andrew M. Neonatal thrombosis: report of a prospective Canadian and international Registry. *Pediatrics* 1995; 96: 939–43.
4. Ades A, Sable C, Cummings S, Cross R, Markle B, Martin G. Echocardiographic evaluation of umbilical venous catheter placement. *J Perinatol* 2003; 23: 24–28.
5. Amato M, Weissmüller A, Hüppi P. Umbilicous venous silastic catheter – a new procedure in low-birth-weight infants. *Neonatologica* 1992; 2: 117–20.
6. Scharrer B, Rudin C, Nars PW. Transumbilical venous access with small diameter silastic catheters in very low birth weight infants. *Eur J Pediatr* 1997; 156: 897–8.
7. Shah PS, Kalyn A, Satodia P, Dunn MS, Parvez B, Daneman A, et al. A randomised, controlled trial of heparin versus placebo infusion to prolong the usability of peripherally placed percutaneous central venous catheters (PCVCs) in neonates: the HIP (Heparin Infusion for PCVC) study. *Pediatrics.* 2007; 119: e284–91.
8. Abdulla F, Dietrich KA, Pramanik AK. Percutaneous femoral venous catheterization in preterm neonates. *J Pediatr* 1990; 117: 788–91.
9. 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: 1246–50.
10. Klein JF, Shahrivar F. Use of percutaneous silastic central venous catheters in neonates and the management of infectious complications. *Am J Perinatol* 1992; 9: 261–4.
11. Harms K, Herting E, Kron M, Schiffmann H, Schulz-Ehlbeck H. Randomized, controlled trial of amoxicillin prophylaxis for prevention of catheter-related infections in newborn infants with central venous silicone elastomer catheters. *J Pediatr* 1995; 127: 615–9.
12. Nadroo AM, Lin J, Green RS, Magid MS, Holzman IR. Death as a complication of peripherally inserted central catheters in neonates. *J Pediatr* 2001; 138: 599–601.

