Research Article

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Misplaced Neonatal Umbilical Venous Catheter: Double Catheter Technique Revisited

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Keywords
Umbilical venous catheter, Double-catheter technique,

Abbreviations
DV: Ductus Venosus, IVC: Inferior Vena Cava, NICU: Neonatal Intensive Care Unit, PV: Portal Vein, QI: Quality Improvement, RA-Right Atrium, UV: Umbilical Vein, UVC: Umbilical Venous Catheter.

Introduction
An umbilical venous catheter (UVC) has been commonly used for more than five decades when a central venous access is needed in the immediate newborn period [1]. It is used to infuse crystalloids, colloids, medications, total parental nutrition, and measure central venous pressure or to draw blood [1-4]. Ideal position for the tip of the UVC is at the junction of the right atrium (RA) and thoracic part of the inferior vena cava (IVC) [1,3]. RA is also an acceptable position [1,3]. The major problem, however, during an insertion of an UVC is the failure to negotiate through the ductus venosus (DV), thereby preventing it from traversing into the thorax. An acceptable position for the UVC is achieved among 45 to 65 % of these neonates [1-4]. The UVC can be miss-guided into the left, the right portal vein (PV), its branch, common portal, splenic, or the mesenteric vein [1-4].

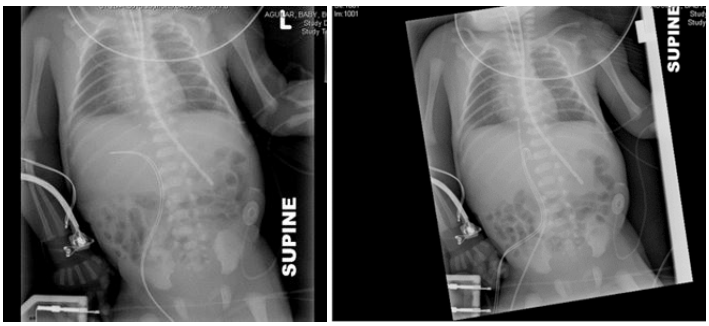
Davis et al. first described the use of a double-catheter technique in two neonates when the first UVC was mis-directed [5]. The second UVC was inserted adjacent to the first UVC left in situ [5]. In a larger study using similar double-catheter technique involving 42 babies, the success rate was 50% [6]. Mis-direction of the first UVC was suspected because of the inability to advance it beyond first 5 to 6 cm, and due to difficulty in drawing blood unless the UVC was pulled back [6]. An abdominal X ray was not performed before inserting the second UVC [6]. In another similar study involving 25 patients, double-catheter technique was successful in 19 (76%) of patients [7]. In both these studies, detail description of how the second UVC was inserted while leaving the first mal-positioned in situ, was not provided.

We modified the double-catheter technique as follows: If the tip of the first mal-positioned UVC, on an abdominal X ray, was angled towards the right of the patient, the second UVC was inserted on the left side of the first UVC. However, if the tip of the first UVC was angled towards the left, the second UVC was inserted on the right side of the first UVC. We hypothesized that angled portion of the mal-positioned UVC will interfere with the successful insertion of the second UVC. Here we report our findings.

Materials and Methods
This study was conducted at Ronald Reagan / Mattel Children's and Santa Monica UCLA hospitals. The NICU at RRH is a quaternary referral unit while the NICU at SMH is a level III unit. The study was considered a Quality Improvement (QI) project in a population of NICU based cohort of neonates. Only the senior Neonatologists attempted the modified double-catheter technique. He was familiar with the original double-catheter technique [5-7] and therefore was comfortable in performing the modified double-catheter procedure. Because this study was considered a QI project and due to the emergent need for the placement of a UVC, separate parental consent was waived.

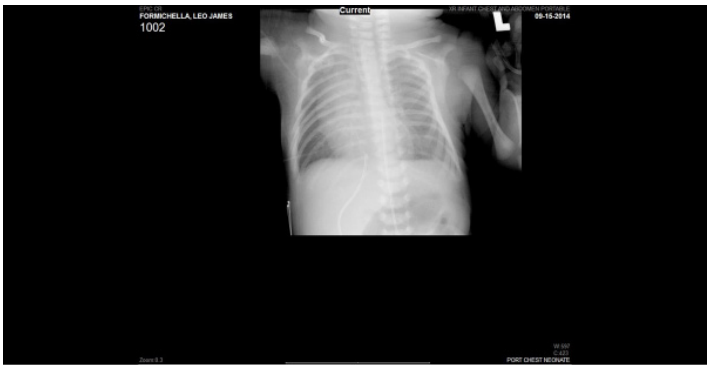
When clinically indicated, 3.5 F (B.W. < 2.5 kg) or 5.0 F (B.W. > 2.5 kg) UVC was inserted as per the NICU protocol [3]. If the Neonatologist was unsuccessful in advancing the tip of the UVC

to an appropriate position, as determined by the X ray examination each time, a second UVC (always 3.5 F) was inserted leaving the first mal-positioned UVC in place [5-7]. If the first UVC was angled towards the right side of the patient, second UVC was inserted on the left side of the first UVC (Figure 1). If the first UVC was angled towards the left of the patient, the second UVC was inserted on the right side of the first UVC. An abdominal X ray was performed to confirm the position of both the UVCs. If the tip of the second UVC was in an acceptable position, mal-positioned first UVC was removed carefully without disturbing the second successful UVC. Both the UVCs were carefully removed, one at a time, if both the UVC were not in a proper position (Figure 1). Babies < 1200 grams B.W. were excluded from the double-catheter technique because of small size of blood vessels potentially leading to an easy rupture and hemorrhage.



A B

Figure 1 A: Mis-directed UVC. **Figure 1 B:** Successful double-catheter UVC.



C

Figure 1C: Second UVC in good position after removing 1st mis directed UVC.

Results

This study was conducted from 2011-2014. Relevant clinical data is shown in Table 1. The major clinical diagnosis included but not limited to late preterm, respiratory distress, sepsis / septic shock, congenital heart disease, hypoglycemia, meconium aspiration syndrome and pulmonary hypertension. All attempts to introduce UVC were made within first 8 hours of age. UVC could be inserted successfully during the first attempt in 52 % of patients. (Table 1). The first mal-positioned UVC was angled towards the right in 41 (82%) and towards the left in 9 (18%) patients. In 24 patients (48%) the second UVC could be successfully inserted and kept in an appropriate position, while removing the first mal-positioned UVC. There was no difference in the success rate of second UVC weather the first mal-positioned was angled toward the right or the left. There were no major immediate side effects like bleeding or cardiac arrhythmia. Figure 1 shows an example of an x-ray film of a UVC mis-directed on the right, and then successful placement of the second UVC and after the mal-positioned first UVC was removed.

Table 1: Demographic Data Mean + S.D. (2011-2014).

Total number of NICU admissions	2296
UVC attempted	735 (32%)
UVC successful	382 (52 %)
UVC not successful	352 (48 %)
No of babies (double-catheter attempted)	50
Birth Weight (double-catheter)	2.42 ± 0.82
Gestational Age Weeks (double catheter)	34.2 ± 1.8
Male / Female (double catheter)	30 / 20 (60 / 40 %)
No. needing ventilation (double-catheter)	26 (52%)
First mal-positioned UVC directed to right	41 (82%)
First mal-positioned UVC directed to left	9 (18%)
Successful second UVC (double-catheter)	24 (48 %)

Discussion

The pathway of fetal umbilical venous flow is UV to left portal vein to DV to abdominal and thoracic part of IVC and eventually the RA [1-3]. The DV joins the left hepatic vein just before they connect with the IVC. It is proposed there is a common orifice for these two vessels, which is partly covered in the lower portion with a thin, transparent membranous valve [8,9]. A sphincter like structure has also been described in the DV at its origin from the UV, both in the sheep and in the human [9]. The DV serves as a bypass for umbilical and portal venous blood. By using angiography, it was suggested that the DV might be influenced by vasoactive substances such as Norepinephrine [9]. It was also shown that the DV responds to changes in the blood flow and pressure [9]. Therefore, it becomes important to understand the entire anatomy of different veins while inserting the UVC and possible mechanisms for the failure to cannulate through the DV resulting in mal-positioned UVC.

Our hypothesis was that our modification of the technique of double-UVC insertion would lead to a better success rate. However, our success rate (48%) was similar to previous studies (50 and 76%) [6,7]. Though we inserted the second UVC on the right or the left side of the first mal-positioned UVC, it is likely after travelling for a short distance in the UV, the second UVC may not retain its right or the left position.

Other method to confirm the placement of the UVC includes use of a point of care abdominal and chest ultrasound (US). It is becoming more popular, especially in a university setting NICU [1]. In addition to the point of care, the advantage of US includes lack of

radiation to the baby. Therefore, it is likely US may become more prevalent in the coming years. However, at present, US machines are still expensive, and there is a lack of adequately trained persons available 24/7. Therefore, it is likely X ray examination will continue to be the gold standard for many years to come, even in the university hospitals worldwide.

In summary, our modification of double-catheter UVC technique failed to increase the success rate any further, extra efforts seem justified in taking care of sick neonates needing a central venous access [5-7] (Figure 2).

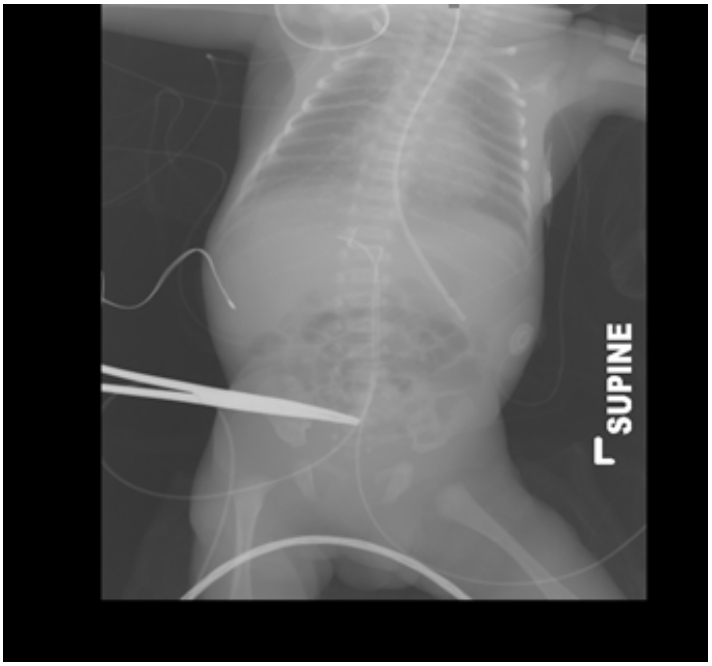


Figure 2: Failed double-catheter UVC.

Acknowledgement

We would like to thank the entire NICU staff and the radiology technicians at both the hospitals for their help and patience during the insertions of UVC. Part of this data was presented in a poster form at the Western Society of Pediatric Research Conference, held in Carmel, California, 2014.

Authorship

Dr. Uday Devaskar was the chief of the Neonatology division from 2011 to 2014. He conceptualized the modified double-catheter technique and performed this procedure whenever possible. He wrote the manuscript. Dr. Pavni Uberoi was a Pediatric Resident in training. This was her research project. She helped in retrieving and analyzing all patient information (data) and presented it at the Carmel meeting. Dr. Monica Sondhi was a Neonatology fellow who assisted Dr. Devaskar many times during the procedure and helped in retrieving patient care information.

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