Migration of Umbilical Venous Catheters

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The umbilical vein is the easiest and most used central venous access in neonates. An umbilical venous catheter (UVC), however, can lead to life-threatening complications in 0.2 to 4% of cases.1–3 Therefore, the advantages of UVCs must be carefully balanced against the potential risks. Incorrect position of UVCs is associated with even higher complication rates.1–7 Accurate confirmation of the correct position after insertion is therefore paramount. The optimal location for the catheter tip is within the inferior vena cava distal to the right atrium.4,6

Migration of peripherally inserted central venous catheters (PICCs) after initial confirmation of a safe position of the catheter tip is known to occur, particularly in PICCs placed in the upper limb.8–10 Migration of UVCs is also described incidentally. This phenomenon is attributed to retraction of the mummifying cord, changes in abdominal girth, lung inflation, and catheter dislocation during manipulations.7,11,12 Gupta et al were the first to document migration of UVCs into the cardiothymic silhouette 1 hour and 12 to 24 hours after initial catheter placement using radiographic assessment.12 Whether migration away from the heart to an unsafe low position occurred remained unclear. Franta et al also reported outward migration of UVCs, but using ultrasound assessment.13 It remains unclear how often UVCs migrate both inward and outward as assessed by radiographic follow-up. As we routinely perform follow-up X-rays at 24 to 36 hours after initial correct placement of an UVC, we will be able to gain insight on this matter.

In this study, we therefore aimed to assess first, the incidence of malposition of UVC tip on X-ray, 24 to 36 hours postinsertion, to prevent complications from malposition.

Objective Migration of umbilical venous catheters (UVCs) after initial correct position has been described. The aim of this study was to assess the incidence of malposition of the tip of the UVCs at 24 to 36 hours postinsertion.

Study Design Retrospective analysis of all neonates who had UVC placement in a 14-month period. The primary outcome was the rate of UVCs incorrectly positioned 24 to 36 hours after initial correct placement, defined as the UVC tip below or more than 5 mm above the level of the right diaphragm on a thoracoabdominal X-ray.

Results We included 86 neonates with a median (range) birth weight of 1,617 (535–5,000) grams, and gestational age of 31 (24–42) weeks. Of the 80 UVCs that were further analyzed, only in 38 (48%) of 80 patients, the tip of the UVC still had a correct position 24 to 36 hours after initial placement. In 22 (28%) of 80 patients, the UVCs had a position that was too high and in 20 (25%) that was too low.

Conclusion More than half of UVCs migrated at 24 to 36 hours postinsertion to positions known to have higher complication rates. We, therefore, recommend follow-up evaluation at 24 to 36 hours postinsertion, to prevent complications from malposition.

Keywords ► umbilical venous catheter ► migration ► X-ray ► neonate

Abstract

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Patients and Methods

We conducted a retrospective observational study in which we included neonates who had an UVC placement. The study was conducted at a single 24-bed tertiary care neonatal intensive care unit in the Netherlands between October 2014 and November 2015. We collected neonatal data including gestational age at birth, birth weight, gender, and catheter-related complications. The study was approved by the local Institutional Review Board.

All UVCs were inserted using the same technique. The insertion length was calculated beforehand using either the Dunn graph14 or the formula of Shukla and Ferrara15 according to the doctor’s preference. No imaging methods were used during the insertion of the UVC. We used either a single-lumen (3.5 or 5.0 Fr diameter, Argyle catheter) or double-lumen catheter (4 Fr diameter, Vygon catheter). According to local protocol, after inserting the catheter, we suture it to the umbilicus and then place it with a downward loop on the abdomen with leucoplast; no dressings are used. For all UVCs, the centimeter marking at the umbilicus is checked and documented 8 hourly.

According to our local protocol, the depth of the catheter tip after initial placement was confirmed using an anteroposterior thoracoabdominal X-ray (TAX), immediately after insertion. We defined a correct position at or within 5 mm above the right diaphragm. The anatomic location and distance from the tip to the right diaphragm were measured in millimeters on the picture archiving and communication system and the tip position was adjusted—only outward—if necessary, in case of a too deep position of the UVC. Repeated radiography was only performed immediately after manipulation in case of catheter retraction of more than 2 cm or in case of manipulation because of curvature or looping of the catheter. Again, the tip position was adjusted—only outward—if necessary. In case retraction less than 2 cm, we assumed the UVC to be in the right position and did not perform a repeated radiography immediately after manipulation. According to protocol, a repeat X-ray to identify migration of the catheter was performed 24 to 36 hours after placement. All X-rays were reviewed by the attending neonatologist and radiologist.

During the 13-month study period, all neonates admitted to the University Medical Center Groningen who had an UVC in place for more than 24 hours were included in the study. We excluded cases without an X-ray 24 to 36 hours after initial placement.

The primary outcome of this study was the incidence of malposition on X-ray, 24 to 36 hours after insertion of the UVCs initially with a correct position. This was evaluated by repeating the anteroposterior TAX. Secondary outcomes were whether migration occurred in- or outward and the effect of birth weight and gestational age on UVC migration.

For statistical analyses, we used SPSS version 23.0 (IBM Corp., Armonk, NY). The Kruskal–Wallis’ test was used to assess differences in both birth weight and gestational age with the migration of UVCs to a position that is either too low or normal or too high. Quantitative data are presented as median values with interquartile ranges. A p-value <0.05 was considered significant.

Results

During the study period, 184 patients underwent umbilical venous catheterization. We present the flow diagram of all patients in Fig. 1. Eighty-four UVCs were removed within 24 hours after insertion because of malposition, for example, in the portal vein. Out of the remaining 100 patients, 86 were included in this study. Fourteen patients were excluded because no X-ray was performed 24 to 36 hours after initial placement, due to death or referral to another hospital (Table 1). Median (range) birth weight was 1.617 (535–5,000) g, and gestational age was 31 (24–42) weeks.

Of the 86 patients, only 17 (20%) had initially a correct placement, 66 (77%) had initially a placement with the tip more than 5 mm above the diaphragm, and 3 (3%) patients had initially a placement with the tip just below the diaphragm, which was accepted by the clinicians because of clinical necessity. Three UVCs with their tips more than 5 mm above the diaphragm were not retracted, for unknown reasons. The three UVCs that had initially a position below the diaphragm and the three UVCs that had a position more than 5 mm above the diaphragm, but were not retracted, were not further analyzed because of this incorrect position (Fig. 1).

Of the 80 UVCs that were further analyzed, 38 (48%) still had a correct position 24 to 36 hours after placement. Forty-two (52%) UVCs had migrated at 24 to 36 hours postinsertion, of which 22 (28%) inward and 20 (25%) outward (Table 2). Of the 22 UVCs that migrated inward, the median position was 12 mm above the diaphragm (range 9–15 mm). Of the 20 UVCs that migrated outward, the median position was 8 mm below the diaphragm (range 5–11 mm).

In 28 patients, the UVCs had correct positions confirmed by X-ray shortly after the process of insertion (Fig. 1): either immediately after insertion (n = 17) or after repeat X-ray after retraction (n = 11). Of the 17 UVCs that had a correct position immediately after insertion, 2 were manipulated for unclear reasons. As no X-ray was performed to confirm a good position after this manipulation, we could only assume these catheters had a good position. Overall, we did not repeat an X-ray in 54 patients after minor manipulation of the line, assuming a subsequent good position of the UVC tip. Of the 26 UVCs that had a radiographically confirmed good position, 11 (42%) still had a correct position at 24 to 36 hours after placement.

Fifteen (58%) had migrated at 24 to 36 hours postinsertion, nine (35%) inward and six (23%) outward (Table 3). Of the nine UVCs that migrated inward, the median position was 12 mm above the diaphragm (range 11–22 mm). Of the six UVCs that migrated outward, the median position was 9 mm below the diaphragm (range 6–12 mm).
Catheter migration was not associated with gestational age (Kruskal–Wallis, $p = 0.58$) or birth weight ($p = 0.95$). None of the neonates in our study developed complications related to the position of the catheter tip.

**Discussion**

In this study, we demonstrated that only less than half of all UVCs (48%) were still in a correct position, 24 to 36 hours after placement. This means that more than half of all UVCs had migrated to possibly hazardous positions, as shown on X-ray. Migration of UVCs is thought to be caused by changes in abdominal girth, lung inflation, and mummification of the umbilical cord.{$^7$,$^{11,12}$}

There is consensus regarding the proper placement of a UVC, which is having the tip of the catheter in the vena cava inferior at or near the junction with the right atrium. Radiographic follow-up is worldwide the most commonly used method for assessment after UVC placement. There is, however, no international consensus on how this correct...
placement of the UVC tip is measured on X-ray. Several studies reported a weak correlation between catheter position in the inferior vena cava on echocardiography and position according to thoracic vertebral bodies on X-ray. \(^1,3,13,16,17\) The cardiac silhouette on X-ray is also not reliable in predicting the correct placement of the catheter tip. \(^13\) Simanovsky et al reported a strong correlation between the findings on ultrasonography and radiography using the diaphragm as a landmark. \(^18\) It is known that the ductus venosus enters the inferior vena cava just below the diaphragm. For this reason, in our hospital, we defined a correct UVC position as having the tip of the catheter at, or just above, the diaphragm.

The tip of the catheter should not be placed in the right atrium, to prevent pericardial effusion and cardiac tamponade. \(^4,6\) Those complications have a high mortality rate. \(^2\) We found that 28% of the UVCs migrated toward the heart within 24 to 36 hours after placement. The studies of Gupta et al \(^12\) and Franta et al \(^13\) found a lower rate of migration toward the heart. We also found a high frequency of outward migration away from the heart (25%). A tip position, that is too low, places the patients at risk for serious hepatic injury due to thrombosis of the hepatic veins or hepatic necrosis due to infusion of medication or hypertonic solutions into the liver. \(^3\) Franta et al reported only 4% migration away from the heart at 24 hours. \(^13\) This differences in migration rate may be due to different definitions of correct position on X-ray and different methods of assessment, chest radiograph versus ultrasonography.

We were struck by the high incidence of migration of UVCs, following a strict protocol. Despite the high frequency of migration of the UVCs, none of the neonates in our study developed complications related to an incorrect positioning. This might be due to our active follow-up and retraction in case of malposition of the UVC, but this study is underpowered to firmly draw this conclusion.

Although we expected that low birth weight and/or low gestational age would result in more migration of UVCs, we found no association between catheter migration and birth weight or gestational age. This is similar to the results of Srinivasan et al \(^6\) and Gupta et al. \(^13,16\) One needs to keep in mind the relative effect of movement of the catheter tip, which will have larger impact in smaller infants compared with larger infants. In the smallest ones, the distance from right atrium to the foramen ovale is only 5 to 10 mm.

Our study has several limitations. First, like most centers worldwide do, we only used the anteroposterior TAX to determine the position of the UVC because this is standard clinical practice in our hospital. Ultrasonography may be superior to radiography because of a possible higher accuracy in determining UVC tip position, being able to assess from various angles, as opposed to the single angle X-ray uses. \(^13,18\) Ultrasonography also avoids exposure to regular ionizing radiation but may not be available 24 hours a day in many hospitals, such as ours. Second, the diaphragmatic position might not be the best reference point for catheter tip position by radiograph. It may be that change in abdominal girth or lung inflation appeared as change in line position relative to diaphragm, but actually, it was in the same position as before. Third, we only performed an X-ray immediately after insertion of the catheter and after 24 to 36 hours. Migration can also occur before or after 24 to 36 hours. \(^13\) Fourth, it is possible that we potentially either missed or overestimated the occurrence of migration. In 54 patients, we did not repeat an X-ray after minor retraction of the catheter, but considered them as having a good position. Although unlikely, it is possible that the catheter was pulled out too far or not far enough. This is not supported by the statistics, both in the radiographically confirmed and the assumed good position groups; we see the same migration rate.

In conclusion, more than half of UVCs had migrated at 24 to 36 hours after insertion to positions known to have a higher complication rate. Therefore, we recommend follow-up evaluation of correct positioning of the UVC at least once at 24 to 36 hours after initial placement. Further studies should elucidate whether this leads to a reduction of UVC-related complications and should also evaluate the need for follow-up beyond this first period. Because of the frequency of these measurements, we recommend to use bedside ultrasonography for this purpose.

Conflict of Interest
None declared.

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