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CASE REPORT

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Point-of-care ultrasound aided diagnosis and management of peritoneal parenteral nutrition extravasation in a preterm baby: A case report

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Key Clinical Message

POCUS could identify some of UVC complications at the bedside. It complements the clinical picture and helps narrowing the deferential diagnosis when there is a clinical deterioration.

KEYWORDS

extravasation, POCUS, preterm, UVC

1 | INTRODUCTION

Central venous access plays a critical role in the care of newborn infants in the neonatal intensive care unit (NICU). In the early days of life, this access is primarily facilitated by insertion of an umbilical vein catheter (UVC) for administration of parenteral nutrition (PN), fluids, and medication. However, it is well described that this form of access does not come without risks, including extravasation, especially when the catheter remains in a suboptimal position. This case reviews an extremely premature infant who developed abdominal distension, acute kidney injury (AKI), and increased inflammatory markers on DOL 2 in context of UVC extravasation. The case helps highlight the high value of point-of-care ultrasound (POCUS) in detecting such complications.

2 | CASE

Baby was born at 23 + 6 weeks gestational age following spontaneous preterm rupture of membranes and delivery with a birth weight of 680 g. Resuscitation included ventilation support and intubation. APGAR scores were 1, 5, and 7 at 1, 5, and 10 min, respectively. Umbilical venous and arterial catheters (UVC, UAC) were inserted, and the baby was admitted to NICU on high-frequency ventilation. Empiric antibiotics, including ampicillin and cefotaxime were started following collection of a blood culture. UVC was reported to be sutured at 5.5 cm, appearing just below the diaphragm on anteroposterior chest and abdomen radiograph and was confirmed by POCUS (Figure 1). The following day, POCUS confirmed the UVC in a good central position, passing through the ductus venosus, with the tip at the right atrium (RA) and inferior vena cava (IVC) junction.

Subsequently, at approximately 48 h of life, baby developed abdominal distention with increased oxygen requirements, leukocytosis, elevated creatinine, and worsened metabolic acidosis. Repeat POCUS showed UVC position in the distal ductus venosus away from the ductus venosus/RA junction, therefore the UVC was further pulled back to a low-lying position. Radiographic image of the chest and abdomen showed significant paucity of bowel gas, concerning for potential ascites, as well as decreased lung field aeration (Figure 2). POCUS of the abdomen and lungs showed moderate to large amount of ascites in all quadrants of the abdomen and bilateral pleural effusions.

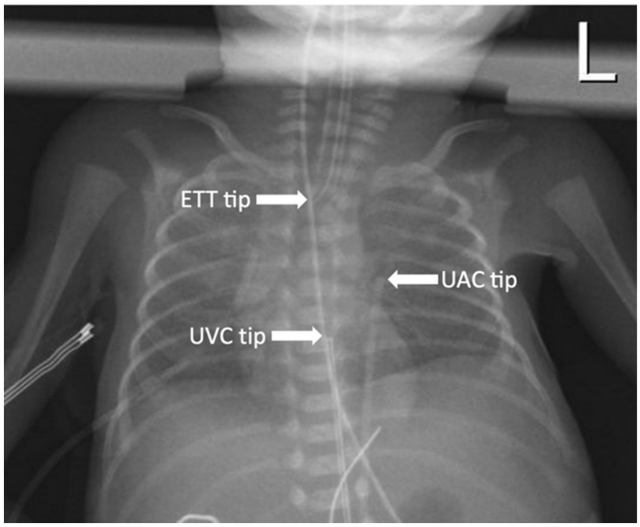

FIGURE 1 Initial radiograph showing the UVC position.

Interestingly, bowels were noted to be echogenic, bright, and concealed, and not floating into the ascites. The loops of the small bowel were compressed, echogenic without substantial internal gas or fluid (Figure 3). Given the physical exam, lab, and imaging findings, the patient underwent ultrasound-guided paracentesis and 29 mL of milky, yellow-colored fluid was aspirated. Paracentesis fluid was notable for elevated glucose concerning for PN, suggesting extravasation from UVC. This emphasizes the importance of using POCUS for the de novo ascites and paracentesis guidance for reaching a certain diagnosis.[1,2] Following removal of UVC and empiric medical management of potential sepsis, with addition of Flagyl, the patient was able to recover. No surgical management was required.

3 | DISCUSSION

The clinical presentation of PN extravasation can be variable and nonspecific, with a broad differential, including sepsis, necrotizing enterocolitis, and even intestinal perforation. Therefore, clinicians must have a low index of suspicion for injuries to abdominal structures related to central lines, especially UVCs when in suboptimal position. Reported rates of malposition of UVC on radiography are reported to be up to 48%, making it the most common UVC-associated complication and a very important factor in the role of developing extravasation.[3] Malposition may not be a direct consequence of suboptimal depth of line at the time of insertion but, instead, related to migration. Inward migration of a UVC may be related to drying of the Wharton jelly and secondary shortening of the umbilical stump while outward migration can occur from gradual distension of the abdomen as bowels fill with gas.[4] A prospective study of ultrasound (US) assessment

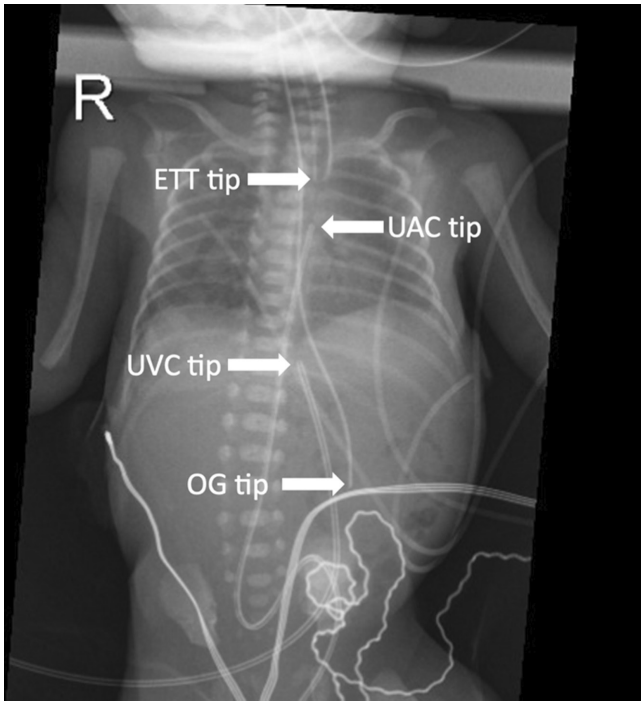

FIGURE 2 Radiograph showing the UVC position upon clinical deterioration.

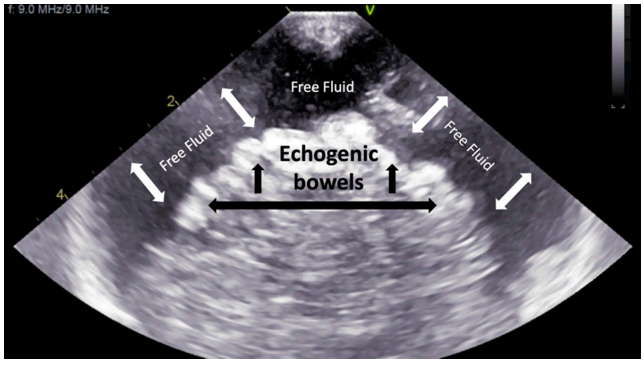

FIGURE 3 Ultrasound appearance of the bowel.

of UVC migration found that UVC tip migration occurred in 50% within the first week after placement.[3] A separate retrospective study, based on chest radiographs, identified that 23% of UVC migration occurred within 24 hours of insertion.[3] Additionally, a 2020 retrospective study found 21.3% of initially properly placed UVCs to have migration of the catheter tip on radiograph. This was defined by tip location below T9 in the paper.[3] It is therefore clear, that suboptimal position of central umbilical catheters is common, even in cases of adequate initial placement.

One of the current challenges includes the lack of standardized guidelines for assessment or monitoring of UVC tip location, securement, management, or dwell time.[3] Additional factors that contribute to the difficulties in preventing extravasation injuries include a lack of standardized technique for line securement, as there is no data

to support one method over another at this time,[3] as well as variable practices in duration of UVC use, both in adequate or low-lying or suboptimal positions.

Abdominal US is more sensitive and accurate in identifying malposition of the UVC tip as compared to radiographs.[1,2] Therefore, in patients with a clinical deterioration and UVC in situ, obtaining an abdominal US should be strongly considered. Having the background skills and knowledge to perform and interpret bedside POCUS may be additionally beneficial in leading clinicians to suspect UVC extravasation as a potential etiology. On review of previously documented US findings of UVC extravasation, a case series including three patients with described appearance of collapsed bowel loops, free fluid/ascites, and echogenic separate debris suggestive of hemorrhage fluid and an echogenic focus in the left lobe of the liver.[5] Additional literature describes the presence of intrahepatic collections in case reports reviewing UVC extravasation, which was not identified in our case.[6–8]

In our literature review, we did not find any reports that focus on describing US findings when extravasation occurs outside the hepatic capsule, predominantly affecting the peritoneum. As described in the case review, we appreciated echoic bowels which were concealed and not floating out into the ascites. This finding led to the bowels having the above-described unique appearance (Figure 2). However, it has been previously documented that hyperechoic spots within the bowel wall may represent the presence of pneumatosis, a radiographic finding of necrotizing enterocolitis (NEC).[9] Additional US findings of NEC include increased bowel wall thickness, decreased perfusion, and change in bowel peristalsis as well as free intraperitoneal fluid. While simple ascites may not be specific for NEC, echogenic fluid or complex collections (with septations) are more likely to be indicative of bowel perforation and a predictor of need for surgical intervention, even in the absence of pneumoperitoneum.[10]

In the context of an infant with a malpositioned venous line, such as a low lying UVC, it therefore becomes imperative to distinguish the etiology of free fluid on US and recognize if this finding is a consequence of NEC, or is exogenous fluid, such as TPN, inappropriately present within the peritoneum, causing secondary injury to the bowels. In our case, the significant compression of the bowels into the "cauliflower head" appearance, without substantial internal gas, led the team to suspect TPN extravasation as a primary cause of injury. Paracentesis and fluid analysis remains a crucial diagnostic test to definitively confirm clinical suspicion for UVC extravasation.

4 | CONCLUSION

This case highlights the US findings of UVC extravasation. Extravasation of fluid into the abdominal cavity can lead to significant injury to intra-abdominal organs, namely the bowels. On US this can be seen as free fluid, or ascites, externally compressing the bowels, demonstrating a cauliflower-like appearance. Injury to the intestines leads to echogenic appearance of the bowels. Additionally, ultrasound imaging of the liver is an important consideration to rule out an intrahepatic fluid collection, namely if UVC placement is within the hepatic vasculature. POCUS can be very helpful detecting those complication and guide the paracentesis when necessary.[3,4] Definitive diagnosis of ascites content requires paracentesis for fluid analysis, which can support US findings.

AUTHOR CONTRIBUTIONS

Alexandra (Ola) Kowalczyk: Writing – original draft; writing – review and editing. **Jagmeet Bhogal:** Writing – review and editing. **Aimann Surak:** Conceptualization; writing – original draft; writing – review and editing.

FUNDING INFORMATION

Not applicable.

CONFLICT OF INTEREST STATEMENT

The authors declare no competing financial interests.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from the corresponding author, [AS]. The data are not publicly available due to their containing information that could compromise the privacy of the participant.

CONSENT STATEMENT

Written informed consent was obtained from the patient to publish this report in accordance with the journal's patient consent policy.

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REFERENCES

1. Michel F, Brevaut-Malaty V, Pasquali R, et al. Comparison of ultrasound and X-ray in determining the position of umbilical venous catheters. *Resuscitation*. 2012;83(6):705-709. doi:10.1016/j.resuscitation.2011.11.026
2. Cao J, Zhang Y, Yin Y, Liu Y. Accuracy of chest radiography compared to ultrasound for positioning the umbilical venous catheter in neonates: a meta-analysis and systematic review. *J Vasc Access*. 2021;7166.

3. Chen HJ, Chao HC, Chiang MC, Chu SM. Hepatic extravasation complicated by umbilical venous catheterization in neonates: a 5-year, single-center experience. *Pediatr Neonatol*. 2020;61(1):16-24. doi:10.1016/j.pedneo.2019.05.004
4. D'Andrea V, Prontera G, Rubortone SA, et al. Umbilical venous catheter update: a narrative review including ultrasound and training. *Front Pediatr*. 2022;9:1-9.
5. Edison P, Arunachalam S, Baral V, Bharadwaj S. Varying clinical presentations of umbilical venous catheter extravasation: a case series. *J Paediatr Child Health*. 2021;57(7):1123-1126.
6. Majid A, Barrett J, Meyer MP. Acute management of intraperitoneal extravasation of total parenteral nutrition (TPN) in a very preterm infant: case report and literature review. *Res Rep Neonatol*. 2021;11:77-81.
7. Ramaswamy VV, Rao GV, Suryanarayana N, Gummadapu S. Parenteral nutrition extravasation associated liver injury – a case series with varying clinicalradiological presentations. *J Pediatr Neonatal Individualized Med*. 2020;9(1):4-7.
8. Pegu S, Murthy P. Ascites with hepatic extravasation of total parenteral nutrition (TPN) secondary to umbilical venous catheter (UVC) malposition in an extremely preterm baby. *BMJ Case Rep*. 2018;2018:4-7.
9. Esposito F, Mamone R, Di Serafino M, et al. Diagnostic imaging features of necrotizing enterocolitis: a narrative review. *Quant Imaging Med Surg*. 2017;7(3):336-344.
10. Alexander KM, Chan SS, Opfer E, et al. Implementation of bowel ultrasound practice for the diagnosis and management of necrotising enterocolitis. *Arch Dis Child Fetal Neonatal Ed*. 2021;106(1):F96-F103.

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