Accidental intracranial infusion of parenteral nutrition in a preterm neonate

Amir Ahmadian, MD,1 Jotham Manwaring, MD,1 Devon Truong, PA-C,2 Jeane McCarthy, MD,3 Luis F. Rodriguez, MD,1,2 Carolyn M. Carey, MD,1,2 and Gerald F. Tuite, MD1,2

1Department of Neurosurgery and Brain Repair, University of South Florida Morsani School of Medicine, Tampa; and 2Neuroscience Institute and 3Department of Neonatology, All Children’s Hospital/Johns Hopkins Medicine, St. Petersburg, Florida

Vascular access in the neonate can be challenging, especially in preterm infants. When other access is not available, superficial scalp veins can be safely used for vascular access. However, rare and potentially catastrophic complications can occur due to unique features of the neonatal skull and soft-tissue anatomy. The authors report a rare complication of vascular access in a preterm infant, which led to the direct infusion of parenteral nutrition into the intracranial space. The child had an excellent outcome after open drainage and irrigation of bilateral intracranial spaces and the spinal thecal sac. Relevant anatomy is illustrated, and an outcome-based literature review is presented on this rarely reported condition. Surgical and conservative management strategies are discussed, along with clinical and radiographic follow-up. Drainage and irrigation is advocated in patients with mass effect, viscous effusions, or declining neurological examination findings.

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Most preterm infants need intravenous access for antibiotics, fluids, prostaglandin E, parenteral nutrition (PN), or other medications. Central venous catheters are often used for longer-term vascular access and administration of PN. Central venous catheter–related complications such as venous thrombosis, pulmonary embolism, retrograde flow, extravasation, and infections have been well described.10,12,15 Administration of intravenous products through peripherally inserted central catheters or peripherally inserted intravenous catheters reduces the inherent risks associated with central venous catheters.3,4 Finding an adequate peripheral vein for access in a neonate, other than the umbilical vein, can be quite difficult due to small vein caliber in the extremities. Scalp veins often offer easier access, being used in up to 50% of premature neonates in some series.7 Widely open fontanelles and sutures raise the possibility of inadvertent intracranial infusion. In this report, we present an exceedingly rare case of accidental intracranial infusion of PN and its neurosurgical management.

Case Report

Birth History and Clinical Course in the First 10 Days of Life

A female infant was delivered by cesarean section at 31 weeks’ gestation, weighing 1040 g, after a pregnancy complicated by oligohydramnios and intrauterine growth restriction. Apgar scores were 8 at both 1 and 5 minutes. The 1st week of life was complicated by methicillin-sensitive Staphylococcus aureus sepsis. Intravenous antibiotics and parenteral nutrition were started on Day 2 of life through the umbilical vein. Due to failed venous access on Day 10 of life, a peripheral scalp intravenous
catheter was placed in the supratrochlear vein parallel to
the metopic suture at the anterior-most aspect of the an-
terior fontanelle.

Diagnosis of Intracranial Infusion of Total Parenteral Nutrition

The child’s head circumference increased by 2 cm in
the 2 days following commencement of PN infusion
through the scalp intravenous catheter. The fontanelle was
tense and bulging, accompanied by a widely split sagittal
suture. A cranial ultrasound revealed new, large bilateral
subdural effusions with mass effect. A small bolus of fluid
was infused through the scalp intravenous catheter dur-
ing cranial ultrasonography, which revealed turbulent flow
directly within the subdural space, suggesting direct infusion
into the intracranial compartment. The intravenous
catheter was then immediately removed, allowing egress
of a milky substance from the puncture site (Fig. 1A). The
patient was then transferred to our center for neurosurgi-
cal evaluation.

On arrival, milky white fluid, consistent with parenteral
nutrition/intralipids, continued to ooze from the previous
scalp intravenous catheter site, accompanied by clinical
signs of high intracranial pressure (ICP) (Fig. 1A). Dur-
ing the primary evaluation the neonate was noted to be
tachycardic, tachypnic, and irritable with abnormal brief
tensor posturing movements. CT scanning revealed
pneumocephalus in the region of the scalp intravenous
catheter and a dilated subdural space (Fig. 2A). A lumbar
puncture also revealed viscous, milky fluid that was diffi-
cult to drain through a spinal needle. Subsequent surgical
evacuation was performed due to evidence of raised ICP,
poor neurological status, and vital sign instability.

Operative Management and Hospital Course

The patient was taken emergently to the operating
room for bilateral subdural and intrathecal drainage and
irrigation. The dura was opened bilaterally at the coro-
nal sutures, exposing pressurized subdural compartments
filled with copious amounts of viscous milky fluid (Video
1; Fig. 1C).

VIDEO 1. Bilateral craniotomies. Bilateral craniotomies performed
at the coronal suture show efflux of pressurized, viscous “milky”
fluid from the subdural/subarachnoid space consistent with parental
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The subdural space was irrigated until clear, and bilateral
subdural drains were left. Based on the preoperative lum-
bear puncture findings, an intrathecal lumbar drain was
placed through a single-level lower lumbar laminectomy
after the intrathecal space was copiously irrigated.

The subdural compartment was irrigated daily with
preservative-free saline through the subdural drains, and
the triglyceride level was followed serially. After 3 days
of drainage, the triglyceride level improved from 1698
mmol/L to 15 mmol/L, allowing for drain removal. Due
to the infant’s recent methicillin-sensitive S. aureus sepsis
and risk for fungal infection from the subdural PN infu-
sion, she was treated with oxacillin and fluconazole for
1 week after surgery. Postoperative MRI showed a small
superficial cystic area within the right frontal lobe deep to
the intravenous catheter site, as well as a decompressed
subdural compartment (Fig. 2B and C). The parenchymal
abnormality was noted on the initial diagnostic cranial ul-
trasound.

The infant had an uneventful recovery after surgery,
with neurological examination findings consistent with
her prematurity. No hydrocephalus, seizures, infection, or
raised ICP developed within the 1st year of follow-up. No
permanent CSF diversion was required. She made neuro-
logical gains typical for a premature child, with mild mo-
tor delay. Her head circumference paralleled the 25th per-
centile, similar to her weight and length. MRI performed
at 1 year showed minimal focal cortical gliosis (Fig. 2C).

Discussion

Indications and Dangers of Scalp Vein Access

Prolonged venous access is necessary in the sick, pre-
mature neonate. The most common indications are the
need for antibiotic therapy, PN, intravenous fluids, vitamin
E infusion, or administration of other medications. Proxi-
mal extremity veins should be preserved for peripherally
inserted central catheter or central line placement, and
distal sites can be difficult to manage due to neighboring
joints and extremity mobility. Umbilical access may be
available up to several days after parturition, but this is
not a good option for long-term access. For these reasons,
the scalp has often been the site of choice for long-term
intravenous access in a premature infant.

The scalp of the neonate provides 4 reasonable options
for venous access: the supratrochlear, anterior facial, su-
perficial temporal, and posterior auricular veins (Fig. 3).
The absence of bone at the sutures and fontanelles cre-
ates unique anatomy in the neonate. Identifying a “danger
zone” related to the vein of interest is crucial for compli-
cation avoidance (Fig. 3). A danger zone includes a su-
perficial scalp vein, its associated underlying suture and
fontanelle, and the underlying dural venous sinus. Inser-
tion techniques for venous access should be directed away
from the suture with blood return to confirm intravenous
placement. Ultrasound can be used to confirm catheter placement within the superficial vein as opposed to dural venous sinus. We propose that one way to avoid intracranial placement may be to place a scalp intravenous catheter only over bone and not over a fontanelle or an open suture line. Despite these efforts, inadvertent intracranial infusion may be unavoidable in some circumstances.

Possible Mechanisms for Intracranial Infusion

Inadvertent intracranial infusion of intravenous fluids, blood products, and PN can be related to direct infusion of a misplaced catheter or due to retrograde flow through thrombosed, valveless scalp veins that communicate with the intracranial compartment. Tuthill et al. showed a transudative ultrafiltrate of total PN (TPN) in the subdural space rather than pure intralipid, supporting the notion of intracranial infusion even in the presence of a correctly placed subcutaneous venous catheter. In our case, pure unfiltered TPN and intralipids were found in the subdural space, suggesting direct infusion.

Management Strategies and Literature Review

Many complications have been associated with scalp intravenous access, including air embolism, retrograde flow, inadvertent subdural placement, and subdural infusion of packed red blood cells. Intracranial infusion of PN has been rarely reported, with variable consequences, including fungal infection, seizures, hydrocephalus, and death. Separating poor outcomes related to intracranial infusion of PN from other complications of prematurity is difficult because of limited detail available in previous case reports (Table 1).

Inadvertent PN subdural infusion has been managed with supportive care, subdural aspiration, or subdural drain placement in previously published cases. Initial reports of supportive care described over 30 years ago resulted in death in both patients, but a good outcome was described in a 2004 report of a patient treated with only supportive care. Similarly, subdural aspiration has resulted in disparate results; 2 patients died and 2 others had a good outcome.

Rare postmortem studies after intracranial PN infusion have provided conflicting results. One autopsy showed lipid-laden macrophages with gliosis, another showed marked pleocytosis, and a third case showed no inflammatory change. We cannot make any definite conclusions about the inflammatory response in our patient because a brain biopsy was not performed at the time of drainage.

We considered observation, aspiration, and drainage in the management of our patient. The initial lumbar puncture revealed viscous, milky fluid. The presence of PN in the spinal subdural space from a hemispheric convexity infusion indicated a global intracranial and spinal space involvement rather than a focal collection. The patient’s increasing head circumference, deteriorating neurological examination findings, the viscosity of the fluid obtained on lumbar puncture, and associated poor outcomes previously reported in the literature prompted surgical intervention. We chose to perform an open procedure instead...
of aspiration to maximize effective drainage and irrigation of the intracranial and intraspinal spaces.

Conclusions

In the rare event of an inadvertent symptomatic subdural infusion of PN, we propose that drainage of the offending agent should be considered. Open drainage and irrigation of the intracranial and spinal compartments resulted in a good outcome in this child.

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**Author Contributions**

**Supplemental Information**

**Videos**


**Correspondence**
Gerald Tuite, Neuroscience Institute, All Children’s Hospital/Johns Hopkins Medicine, 601 5th St. S, Ste. 511, Saint Petersburg, FL 33701. email: geraldtuite@gmail.com.