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Inadvertent intrathecal cannulation in an infant, demonstrated by three-dimensional computed tomography: a rare complication of internal jugular vein catheterization

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Abstract We describe a case of inadvertent intrathecal cannulation with a central venous catheter in an infant, confirmed by three-dimensional computed tomography, which clearly demonstrated the track of the catheter. We believe that this complication could have been related to two major factors: depth of needle insertion and penetration of the vein by a straight-tip guidewire. To avoid this complication, the depth of needle insertion must be carefully checked, a "J"-tipped rather than a straight-tipped guidewire should be used, and puncture should be guided by ultrasound.

Key words Intrathecal cannulation · Internal jugular vein · Guidewire · Migration · Three-dimensional computed tomography

Introduction

Central venous catheterization via the internal jugular vein (IJV) is widely performed in anesthesia for pediatric cardiac surgery. The migration of a central venous catheter (CVC) into the intrathecal space is a rare complication that has been reported previously in adults [1,2]. There is only one report of cervical dural puncture in a neonate as a complication of internal jugular venipuncture [3]. We report a case of inadvertent intrathecal cannulation with a CVC in an infant following cardiac surgery, confirmed by standard and three-dimensional computed tomography (3D-CT) scanning.

Case report

A 9-month-old, 5.2-kg female child was admitted to the intensive care unit (ICU) with a diagnosis of low cardiac output syndrome after the surgical closure of a ventricular septal defect. Intravenous fluid had spilled around the site of insertion of a CVC placed in the right IJV 7 days previously, and the skin where the inserted CVC exhibited reddening, swelling, and tenderness, indicating local infection. It was planned to place a new CVC in the left IJV.

Before cannulation, the left carotid artery and IJV were identified at a depth of 10 mm, using surface ultrasound (Sonos 450; Hewlett-Packard, Andover, MA, USA). Cannulation was attempted without ultrasound guidance, using the carotid arterial pulsation near the bifurcation of the sternocleidomastoid muscle as a landmark. Venipuncture was performed with a 22-G over-the-needle cannula (Arrow double-lumen catheter 4 Fr × 13 cm; Arrow International, Philadelphia, PA, USA), inserted at a 45° angle and directed toward the ipsilateral nipple. The needle was advanced to a depth of 20 mm, and then withdrawn slowly to a depth of 15 mm, where free reflux of venous blood was obtained. Passage of the curved tip of a J-wire was attempted, without success, and the insertion and passage of the straight end of the guidewire was successful, without any resistance. A dilator was threaded over the guidewire, and a double-lumen catheter was inserted for 5 cm without difficulty.

Aspiration of the distal lumen of the catheter yielded only a small amount of serosanguineous fluid. A chest radiograph was obtained (Fig. 1), which showed unusual positioning of the catheter. A CT scan (Fig. 2) confirmed that the CVC tip had been placed in the intrathecal space. Analysis of the fluid aspirated from the catheter (Table 1) suggested that the catheter tip was in the intrathecal or pleural space. The CVC was therefore immediately removed. Three-dimensional CT reconstruction was performed (Fig. 3). Magnetic resonance (MR) imaging of the spinal cord was normal. No neurological or infectious complications were encountered, and the patient was discharged 3 months after catheter aspiration.

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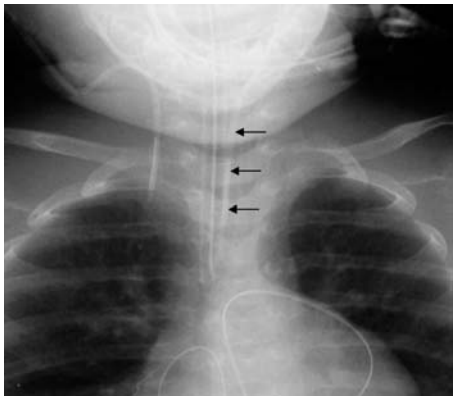

Fig. 1. Chest X-ray. A central venous catheter had been placed correctly in the right internal jugular vein. However, this catheter, which had been directed at the left internal jugular vein, was positioned in the center of the vertebral body (shown by *black arrows*)

Discussion

We report a case of intrathecal cannulation in an infant, demonstrated by 3D-CT. CT and 3D-CT imaging clearly revealed the course of the catheter. The CVC passed through the C6-7 intervertebral foramen, then anterior into the intrathecal space, after having penetrated the dura. It then advanced counterclockwise and posterior to the back of the spinal cord, with the CVC tip at the level of the T2 intervertebral disc.

Several complications of IJV placement have been reported in adults, including inadvertent cannulation of the cervical epidural venous plexus [4] or extradural space [5], retrograde cannulation of the intrathecal space [1], and the placement of a Swan-Ganz catheter in the intrathecal space [2]. In pediatric patients, we found only one report of inadvertent cervical dural puncture, in a neonate, as a complication of internal jugular puncture [3].

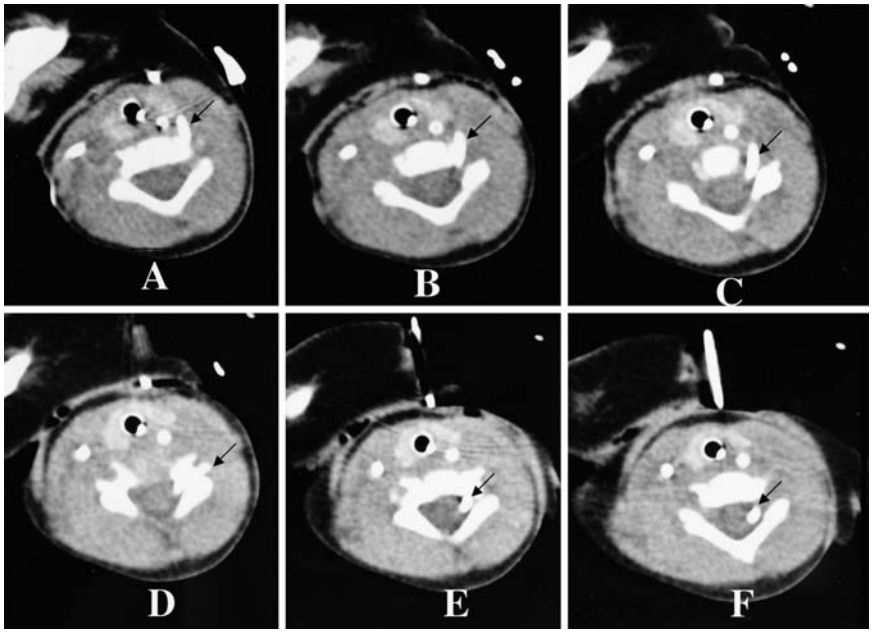

Fig. 2A–F. Computed tomography scanning of the neck. The left side of each image is the anatomic right. **A** The catheter is observed in a location where it may enter the foramen. **B–D** The catheter is imaged where it enters the C6-C7 intervertebral foramen and approaches the intrathecal space. **E** and **F** The catheter has migrated into the left lateral intrathecal space. No deformation of the cord or hematoma is observed. *Arrows* show catheter positions

Table 1. Laboratory findings in fluid aspirated from catheter

	Aspirated fluid (CSF normal range)	Arterial blood[a]
Na (mEq·L^{-1})	134 (20–250)	134
K (mE·L^{-1})	2.4 (0.2–3.0)	4
Cl (mE·L^{-1})	114 (20–250)	96
Total protein (g·dl^{-1})	0.21 (0.15–0.45)	6.5
Glucose (mg·dl^{-1})	85 (50–80)	142
WBCs (·µl^{-1})	16 (0–5)	17300
RBCs (×10000·µl^{-1})	15 (0)	319

CSF, cerebrospinal fluid; WBCs, white blood cells; RBCs, red blood cells
[a] Patient data

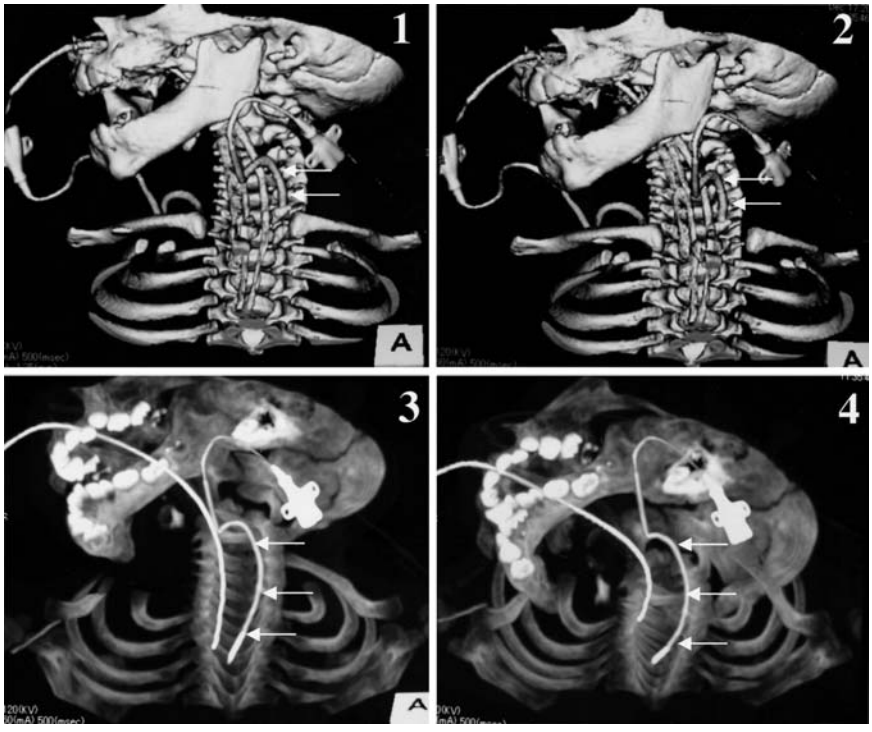

Fig. 3. Three-dimensional computed tomography of the neck. The left side of each image is the anatomic right. Images *1* and *2* show that the catheter is advancing in the C6-C7 intervertebral foramen (shown by *white arrows*). Images *3* and *4* show that the catheter has advanced counterclockwise to the back of the spinal cord in the intrathecal space (shown by *white arrows*). An endotracheal tube proceeds from the right nostril into the trachea

The complication we report may have been related to our technique of jugular puncture and catheterization. Two major factors probably contributed to the inadvertent intrathecal cannulation: depth of needle insertion and penetration of the vein by the straight-tip guidewire.

Previous reports [3,6,7] have pointed out that the first major factor in inadvertent intrathecal cannulation was incorrect depth of needle insertion. In our patient, MR imaging, performed to rule out injury of the spinal cord (not shown), revealed that the distance to C6 from the skin was almost double that to the IJV. The mean distance to the IJV in pediatric patients [7] is 8 ± 2 mm (mean ± SD).

The needle used for venipuncture was indeed situated in a vein, since we obtained free reflux of venous blood, but insertion [6,7] was too deep for the IJV. We therefore speculate that the vein cannulated by the needle was the vertebral vein or cervical epidural venous plexus, and not the IJV. Also, the IJV was too far for the guidewire to penetrate the dura into the intrathecal space. Moreover, arteriovenous fistulas between the vertebral artery and venous plexus [8] have been reported.

The straight tip of the guidewire was used because attempts at passing the curved end were unsuccessful. This method is successful in infants; inability to pass the curved end of the J-wire is thought to be due to the radius of curvature's being larger than the diameter of the vein in small infants [9]. In our patient, the straight end of the guidewire may have penetrated the venous wall and the dura into the intrathecal space. Our experience suggests that that use of the straight end of the guidewire should be avoided, if possible. If it is necessary to use the straight end, we must be aware of this complication.

There is variability in the anatomical relationship of the IJV and carotid artery [10]. Thus, to improve the rate of success of IJV cannulation [11], ultrasound-guided cannulation has been recommended. In the present patient, ultrasound was used to confirm the position of the IJV before the attempted cannulation, but not during the procedure itself, because the anesthesiologist was unfamiliar with puncture under ultrasound guidance. In infants, ultrasound guidance for IJV cannulation has been reported to increase the rate of success of cannulation, and to reduce the number of attempts, the rate of carotid artery puncture, and the time to successful cannulation [9]. It may be necessary to master a technique which requires that one anesthesiologist holds the sheathed probe with one hand and advances the cannulation needle with the other hand, while watching the image on the screen [9].

In summary, we have described a case of inadvertent intrathecal cannulation in an infant, confirmed by 3D-CT.

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