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Cerebral herniation associated with central venous catheter insertion: Risk assessment☆,☆☆,★

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Abstract

Purpose: Central venous catheters (CVCs) are often necessary to treat acute brain-injured patients. Four cases of cerebral herniation immediately following central venous catheterization were the impetus for an investigation of clinical and radiologic parameters associated with this complication.

Materials and Methods: This is a case series of 4 consecutive patients who experienced clinical cerebral herniation immediately following CVC placement in Trendelenburg or supine position. Clinical and computed tomography imaging findings were reviewed.

Results: All 4 patients developed new-onset clinical signs of cerebral herniation (unilateral or fixed dilated pupil and Glasgow Coma Scale [GCS], 3) within 30 minutes of the procedure. All had radiographic signs of Sylvian fissure and/or basal cistern effacement on the preceding computed tomographic scan secondary to unilateral or bilateral mass lesions. Preprocedure GCS was 8 or more in all cases. Herniation was medically reversed in 3 of 4 patients, and 1 patient died of progressive brainstem ischemia.

Conclusions: Trendelenburg and even flat position during CVC placement can increase intracranial pressure leading to cerebral herniation in patients with significant intracranial mass effect. Careful review of neuroimaging for signs of impending herniation before inserting CVCs and choosing an alternative treatment plan in these cases may avoid this potentially underreported complication.

1. Introduction

Central venous catheters (CVCs) are indicated in the acute brain injured patient for aggressive fluid resuscitation, administration of hypertonic and vasopressor therapy, assessment of central venous pressures, and for reliable venous access. In general, catheterization of the subclavian vein is the preferred site due to lower infectious and thrombotic complications compared with catheterization of the femoral vein [1] and lower risk of intracranial complications than with the internal jugular site. Subclavian line placement is generally not used during emergency catheterization for life-threatening situations or when the patient cannot tolerate Trendelenburg position. Increased intracranial pressure (ICP) is a potential risk of Trendelenburg position for placement of subclavian and jugular venous catheters [1]. However, little data exist on how to evaluate

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this risk especially in patients who do not have an ICP monitor. During a 13-month period, we identified 4 patients with clinically diagnosed cerebral herniation temporally associated with either supine or Trendelenburg position for the purpose of central venous catheterization. This is the first report of clinical herniation associated with this procedure that we are aware of. We hope to provide information that will allow clinicians to recognize the risk of this condition more readily, intervene promptly, and prevent this complication whenever possible.

2. Methods

We identified 4 cases of with new onset clinical manifestations of cerebral herniation immediately following CVC placements over a 13-month period (September 2009-2010) in patients admitted to our neurocritical care unit. We performed a retrospective analysis of the following patient information using electronic databases, patient charts, and interviews with residents and fellows: patient demographics, admission diagnosis, pre-CVC and post-CVC insertion vital signs, neurologic assessments including Glasgow Coma Scale (GCS) and pupillary findings, patient positioning, radiographic findings, and serum sodium. *Clinical herniation* was defined as new onset of a unilateral or bilateral fixed dilated pupil with decrease in GCS 2 points or higher. Outcomes of interest were best GCS at 24 hours after CVC insertion, time to GCS recovery to preprocedure level, reversal of clinical herniation, and evidence of permanent neurologic injury related to herniation at hospital discharge. No patient had an ICP monitor before the procedure. The study was approved by the Johns Hopkins Medicine Institutional Review Board.

Central venous catheters were placed by intensive care unit physician staff using standard protocol for percutaneous placement of subclavian vein CVCs. All lines were placed under clinical supervision of the clinical fellow or neurocritical care attending physician. Consistent with recommendations, to optimize venous filling and especially to prevent air embolism, the patient was positioned in supine position with head of bed (HOB) at either 0° or at 15° head down (Trendelenburg). The site was prepped with chlorhexidine and a local anesthetic (1% lidocaine) was used at the venipuncture site. In 1 case (no. 4), the patient was premedicated with intravenous fentanyl (50 μg) and versed (2 mg). The subclavian vein was accessed with a large caliber needle and syringe held parallel to the frontal plane. The guide wire was inserted while monitoring the electrocardiogram for rhythm disturbances. The needle was removed with the guide wire held in place, followed by dilation of the tract. The catheter was then inserted over the guide wire to a predetermined depth to place the tip at the junction of the superior vena cava with the right atrium. The HOB was returned to 30° upright. A confirmatory chest x-ray was obtained to assess for line position and complications. All patients receive minimal sedation to treat discomfort related to the presence of endotracheal tubes and mechanical ventilation. Patient 4 received a propofol infusion for intracranial pressure management after the procedure. Sedation was routinely held to assess GCS post procedure.

3. Results

Over the period of these events, 466 central lines were placed in patients admitted to the neurocritical care unit. Table 1 describes the case patients' age, diagnoses, procedure, management, and their outcomes. No patient had clinical signs of a cerebral herniation syndrome before CVC placement at which time GCS ranged from 8T to 13. All lines were placed in the subclavian vein using Trendelenburg at 15° head down or supine position at 0° (flat). Indications for line placement were for administration of volume resuscitation, vascular access, and administration of hypertonic saline for treatment of cerebral edema and mass effect. Peripheral lines were in place for all cases, and none of the CVC placements were emergent. No intravenous sedation was given. Clinical signs of cerebral herniation were recognized within 30 minutes of CVC placement in all cases and occurred immediately after insertion in 2 cases while still in supine position. Glasgow Coma Scale was 3 in all cases, and all patients had unilateral or bilateral large nonreactive pupils, with pupillary asymmetry. Motor responses to deep stimulation were absent, no posturing was observed, and lower cranial nerve function (corneal reflexes, cough, and gag reflexes) was preserved with the exception of patient 3 who did not recover. Other than the placement of CVC, no other clinical parameters changed before the observation of clinical signs of cerebral herniation. Given this observation, the association of HOB position and CVC placement was the only physiologic event that could have triggered decompensation leading to cerebral herniation. Management of cerebral herniation included hyperventilation, intubation (2 cases; the other 2 patients were already intubated) and administration of hyperosmolar therapy via the newly placed CVC. Time to achieve serum sodium greater than 145 mmol/L ranged from 2.5 to 10 hours. Two patients also had decompressive surgery on the same day as the herniation event. Table 2 compares GCS score at time of admission, before and immediately after the CVC procedure, and at 24 hours after CVC insertion. Three patients recovered to their pre-CVC insertion GCS within 8 to 60 hours after the event and had full recovery of cranial nerve reflexes and motor function without evidence of permanent neurologic injury related to the herniation event. One patient (no. 3) died on day 4 after continued neurologic deterioration from brainstem strokes leading to decision for withdrawal of care.

Fig. 1 and Table 3 describe the radiographic findings on the computed tomographic (CT) scan most proximal to the