CASE REPORT

Iatrogenic injury of vertebral artery resulting in stroke after central venous line insertion

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SUMMARY

There are many complications of central venous catheter insertion. Iatrogenic injury of the vertebral artery is a rare complication that can result in severe morbidity and mortality. The case presented describes the complication of an acute ischaemic stroke after cannulation of the vertebral artery. There are various techniques when obtaining central access, however the best practice as described by the evidence based guidelines produced by the American Society of Anesthesiologists utilises real-time ultrasound guidance to minimise adverse events.

BACKGROUND

Central venous catheterisation (CVC) is a very common procedure used in a critical care or perioperative setting. Cannulation of the internal jugular vein (IJV) is commonly used due to its easy access, relatively clean site and proximity to the heart.¹ Despite being a relatively safe procedure, even when conducted under ultrasound guidance, it is not without complications, with rates as high as 15%.^{1–3} Common complications include infection, haematoma, thrombosis, haemothorax and pneumothorax.² Cannulation of the IJV has specific complications, in particular, a higher incidence of arterial cannulation when compared with the subclavian vein.^{2,4} The carotid artery is most commonly injured however a rare complication is iatrogenic injury to the vertebral artery.^{5,6} Complications of vertebral artery cannulation include arteriovenous fistulas, lacerations, pseudoaneurysm and dissection with thrombosis leading to acute neurological injury.⁵ This case report reviews a rare but severe complication of vertebral artery cannulation leading to stroke after attempted CVC insertion and recommendations suggested in the practice guidelines for CVC access by the American Society of Anesthesiologists (ASA).¹

CASE PRESENTATION

A 71-year-old slim woman presents to the emergency department with gradual onset generalised abdominal pain with coffee ground vomiting. Her medical history includes previous cholecystectomy, hysterectomy and bilateral ureteric stents for congenital vesicoureteric junction obstruction complicated by recurrent urinary tract infections. On initial examination, her vital signs were unremarkable and her abdomen was guarded with generalised tenderness. Further investigation with a CT

scan of her abdomen with contrast identified a small bowel obstruction (SBO) with a transition point in the distal ileum and was not able to exclude bowel ischaemia. Correlation with her blood lactate at 2.6 mmol/L (normal value <2 mmol/L) and abdominal pain raised the suspicion of ischaemic small bowel. After review by the general surgical team, the patient was taken for an emergency laparotomy which confirmed SBO and identified a portion of ischaemic small bowel requiring resection. Prior to the procedure after induction of anaesthetic, the anaesthetic team attempted to insert a CVC into the right IJV to administer norepinephrine for hypotensive shock. Successful cannulation was achieved after the second attempt. During the first attempt, ultrasound was used to visualise the anatomy prior to insertion of the catheter but was not used during the procedure or prior to the second attempt. The anaesthetic team reported difficulty inserting the guide wire during the initial attempt and the procedure was reattempted with success. Confirmation of venous insertion with pressure waveform analysis or venous blood gas sampling was not conducted immediately after insertion. During the procedure, the CVC was mainly used to administer norepinephrine for hypotensive shock as well as fluids and antibiotics.

Postoperatively, the patient was transferred intubated to the intensive care unit for further management. To confirm CVC placement, a chest X-ray was conducted (figure 1) which confirmed appropriate positioning of the catheter tip, presumably in the superior vena cava and excluded immediate complications such as pneumothorax. A venous blood gas from the catheter revealed an abnormally high pO₂ 199 mm Hg (normal range 80–95 mm Hg) and pCO₂ 45 mm Hg (normal range 36–44 mm Hg), raising suspicion of arterial cannulation. The norepinephrine infusion was immediately ceased and peripheral boluses of metaraminol were administered. At this stage, the patient's pupils were 2 mm bilaterally with no lateralising signs. No further imaging was conducted and the intubated patient was taken to theatre by the vascular team for urgent neck exploration for a suspected carotid artery cannulation.

TREATMENT

An incision was made from the catheter entry site on the skin towards the suprasternal notch. The catheter was traced along its tract and passed through the right IJV and right vertebral vein to enter the lumen of the right vertebral artery before

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Figure 1 CXR post CVC insertion, right IJV CVC tip lies within the proximal to mid SVC. No pneumothorax or complicating feature. CVC, central venous catheterisation; CXR, chest X-ray; IJV, internal jugular vein; SVC, superior vena cava.

its entry in the cervical canal. The artery was intact and was isolated above and below the catheter entry site. The catheter was removed and bulldogs applied to the vessel. The lumen was flushed and checked for forward and backward flow. The adventitia was cleared and the edges freshened. The arterial wound was successfully closed transversely with interrupted 7/0 Prolene. Prior to extubation, the patient's pupils remained 2 mm and reacted to light bilaterally. On day 1 postextubation, she was noted to be drowsy but was able to follow one step commands with no lateralising features on neurological examination. The drowsiness was thought to be secondary to a fentanyl infusion. No imaging was conducted postoperatively to assess patency of the vertebral artery. After the cessation of the fentanyl infusion on postoperative day 2, the patient with Glasgow Coma Scale score of 15 however was reported to have left homonymous hemianopia with no other neurological features.

OUTCOME AND FOLLOW-UP

Subsequent investigation with MRI of her brain at day 4 post-operation identified multiple areas of acute infarction, predominantly over the right parieto-occipital region, characterised by cytotoxic oedema. Multiple small peripheral bilateral cortical infarcts through a watershed distribution were identified particularly over the left anterior, middle and posterior cerebral artery territories. All of these lesions show cytotoxic oedema consistent with recent infarction; however, it is difficult to determine when the stroke occurred, the possibilities include at the time of CVC insertion (two punctures), during surgical repair or postoperatively.

After review by the neurology team, the likely aetiology of the homonymous hemianopia was due to acute infarction from embolic plaque or pericatheter thrombus from the vertebral artery injury. The patient was commenced on oral aspirin immediately and then clopidogrel 14 days after. As there were no other neurological deficits, the patient was reviewed by the ophthalmology team and then discharged home on day 14 after a short admission under the rehabilitation team.

Figure 2 Vertebral artery (black arrow) in relation to the IJV. IJV, internal jugular vein.

DISCUSSION

This is the fourth case of vertebral artery puncture causing stroke to be reported in the literature.^{3 7 8} Only in the second case, the patient survived after developing a stroke. The first reported case by Riebau *et al* identified the catheter lateral and posterior to the right IJV without puncturing it, piercing the right vertebral artery with the tip located in the aortic arch.⁷ In both cases, the patient underwent right neck exploration for removal of the CVC and primary repair of the vertebral artery. The case presented is unique in that the needle managed to penetrate through three vascular structures—the right IJV, right vertebral vein and right vertebral artery. Prior to surgical exploration, it was presumed that the right carotid artery was cannulated given its proximity to the IJV.

Cannulation of the vertebral artery, although rare can occur when the needle is directed lateral or too deep in relation to the IJV (figure 2).^{3 9 10} The IJV is usually located 1–1.5 cm below the skin.¹¹ The normal course of the vertebral artery as it branches from the subclavian artery is divided into four segments.^{3 12} The most common area of injury is the first segment, from the origin to the transverse foramen of cervical vertebrae 6 (C6), followed by the second segment between C6 and C2.¹³ In comparison, due to closer anatomical proximity, rates for carotid artery cannulation are much higher with incidence between 0.5% and 11.4%.¹³ The severity of complications after cannulation of the vertebral artery are more severe.¹³ Not only is the risk of stroke higher with vertebral artery cannulation when compared with the carotid artery, symptoms often present late to raise clinical suspicion.^{13 14} The high mortality risk from vertebral artery cannulation is thought to be from impaired brain stem circulation.^{3 8}

In order to prevent these life-threatening complications, the ASA has developed practice guidelines to aid clinicians with evidence-based practice of central line insertion.¹ After review of multiple meta-analyses by the ASA, there is level 1 evidence to support the use of real-time ultrasound-guided CVC insertion of the IJV.¹ This technique has a higher initial attempt success rate, higher overall successful cannulation and reduced rates of arterial cannulation.^{1 15} Although the case presented applied static ultrasound to confirm anatomy prior to insertion, the team failed to apply real-time ultrasound to visualise cannulation of the IJV. After presumed venous cannulation, the guidelines

Learning points

- ▶ Best practice guidelines by the American Society of Anesthesiologists need to be taught and implemented, ideally reviewed prior to a procedure.
- ▶ Ultrasound should be used at each stage—before, during and after central venous catheterisation insertion to ensure correct placement.
- ▶ Venous cannulation should be confirmed by blood gas sampling and/or pressure waveform analysis.
- ▶ When arterial injury is suspected, the wire or catheter should be left in place and surgical advice sought.
- ▶ When vertebral artery injury is suspected, vascular intervention should be prompted for best results.

suggest confirming success by various methods including ultrasound (transthoracic or transoesophageal echocardiography), manometry, pressure-waveform analysis or venous blood gas measurement.^{1 15}

In the event of a suspected arterial cannulation, the guidelines recommend discussion between vascular/general surgical team or interventional radiology for planning removal.^{1 6} A case series of arterial trauma after CVC insertion by Guilbert *et al* outlines the options of pull and press, endovascular or open repair.⁶ An algorithm for arterial cannulation was derived after review of 13 cases. The algorithm suggests to leave the catheter in place if ≥ 7 French and if the area is easily accessible, then consider open surgical exploration and if not, then consider treatment with a covered stent or percutaneous closure device.⁶ Both management options require neurological monitoring. It is important to note that the case series did not include any vertebral artery injury. Management of vertebral artery injury may not conform to the described algorithm due to its deep anatomical location and severe consequences of injury.

The use of real-time ultrasound when inserting central access is essential to prevent the rare occurrence of vertebral artery injury and the severe complications associated with this. If arterial cannulation is suspected, ideal management should involve surgical review for removal.

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