Title

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Publication Date

2024-08-01

DOI

10.1016/j.tcr.2024.101065

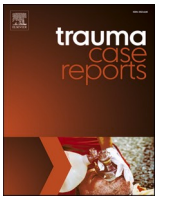
Peer reviewed

Trauma Case Reports 52 (2024) 101065

Contents lists available at ScienceDirect

Trauma Case Reports

journal homepage: www.elsevier.com/locate/tcr



Case Report

Subclavian line infiltration causing neck compartment syndrome and bradycardic arrest: A case report

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ARTICLE INFO

Keywords:
Subclavian
Central venous catheter
Trauma surgery
Massive transfusion
Neck compartment syndrome

ABSTRACT

Unrecognized central venous catheter (CVC) infiltration is an uncommon but potentially life-threatening complication. For instance, a malpositioned subclavian line can infuse into the mediastinum, pleural cavity, or interstitial space of the neck. We present the case of a 30-year-old male with gunshot wounds to the right chest, resuscitated with an initially functional left subclavian CVC, which later infiltrated into the neck causing compression of the carotid sinus and consequent bradycardic arrest. Return of spontaneous circulation (ROSC) was achieved following intravenous epinephrine, cardiac massage, and emergency neck exploration and cervical fasciotomy. Our case highlights the importance of frequent reassessment of lines, especially those placed during fast-paced, high-intensity clinical situations. We recommend being mindful when using rapid transfusion devices as an interstitial catheter may not mount enough back pressure to trigger the system's alarm before significant tissue damage or compartment syndrome occurs.

Introduction

Emergent central venous cannulation is commonly performed in hemodynamically unstable trauma patients to facilitate massive transfusion. Given the frequent need for cervical spine immobilization in this population, the subclavian or femoral veins are frequently accessed. CVC complications occur at an overall rate of approximately 15 percent [1,2] and can be categorized as early or late. Regularly cited early mechanical injuries include pneumothorax, arterial puncture, hematoma, and malposition. Infiltration of fluids or extravasation of a vesicant is an infrequent mechanical complication (although likely underreported) occurring at a rate of approximately 0.1 to 6 percent [3]. Depending on the site of cannulation, infusates can infiltrate into extravascular locations such as the abdominal cavity, pleural cavity, or mediastinum. Previous case reports have highlighted life-threatening conditions caused by infiltration such as hydrothorax [4,5], hydroperitoneum [5], hydromediastinum [6], abdominal compartment syndrome [7], and airway obstruction [8]. Here, we report a rare scenario in which a previous functional left subclavian CVC infiltrated, leading to a neck compartment syndrome causing intraoperative bradycardic arrest.

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https://doi.org/10.1016/j.tcr.2024.101065
Accepted 4 June 2024
Available online 5 June 2024

Case description

A 30-year-old male was brought into the emergency department following two gunshot wounds to the right chest. CPR had been ongoing for approximately 5 min prior to handoff. On arrival, the patient was intubated immediately, and left femoral and left subclavian 9-French introducer sheath CVCs were placed by anatomic landmarks and confirmed by positive blood return to facilitate massive transfusion. A resuscitative thoracotomy was performed, and a right chest tube was inserted with an immediate large output of blood. The incision was converted to a clamshell thoracotomy, the aorta was cross-clamped, and the right hilum was clamped due to hemorrhaging lung lacerations. ROSC was achieved after approximately 15 min, and the patient was emergently transferred to the operating room.

Intraoperatively, large volume balanced transfusion continued via a rapid transfuser connected to the left subclavian line. Surgically, a stapled tractotomy of both the right upper and lower lobes was completed. A partial non-anatomic wedge resection was performed on an ischemic area of the right lower lobe. Serial arterial blood gases indicated improving metabolic acidosis, anemia, electrolytes, and lactate. Hemodynamically, the patient's blood pressure stabilized.

During the closure of the clamshell thoracotomy incision, the patient suddenly became increasingly hypotensive and was only temporarily responsive to treatment with volume and vasopressors. Repeat arterial blood gases began to show worsening anemia despite transfusion. Shortly thereafter, the patient's heart rate rapidly decreased from approximately 115 to 30, with a corresponding systolic blood pressure of 40. Epinephrine 1 mg was administered intravenously, which improved arterial blood pressure and pulse only briefly. Concurrently, the chest was reopened and internal cardiac massage was initiated. Surgical hemostasis was reconfirmed yet he displayed worsening anemia, prompting examination of the left subclavian CVC. The patient's neck appeared markedly engorged (left more than right), and the tissues were extremely tense to palpation. The central venous catheter tip remained under the skin but had clearly retracted backward, despite being sutured to the skin using the suture eyelet on the catheter hub. We diagnosed the patient with neck compartment syndrome causing a carotid sinus reflex resulting in bradycardic arrest. The rapid transfuser device was immediately stopped and disconnected. The surgical drapes were lowered, the neck was exposed and quickly sterilized with betadine, and an emergency left neck exploration and cervical fasciotomy was performed. An incision was made along the anterior border of the left sternocleidomastoid muscle and carried down through the subcutaneous tissue. Due to the obliterated anatomy, an ultrasound and doppler were used to safely locate and open the carotid sheath. The persistent bradycardia and hypotension terminated following dissection and opening of the carotid sheath. At the end of the case, a chest x-ray was taken (Fig. 1), which displayed subcutaneous

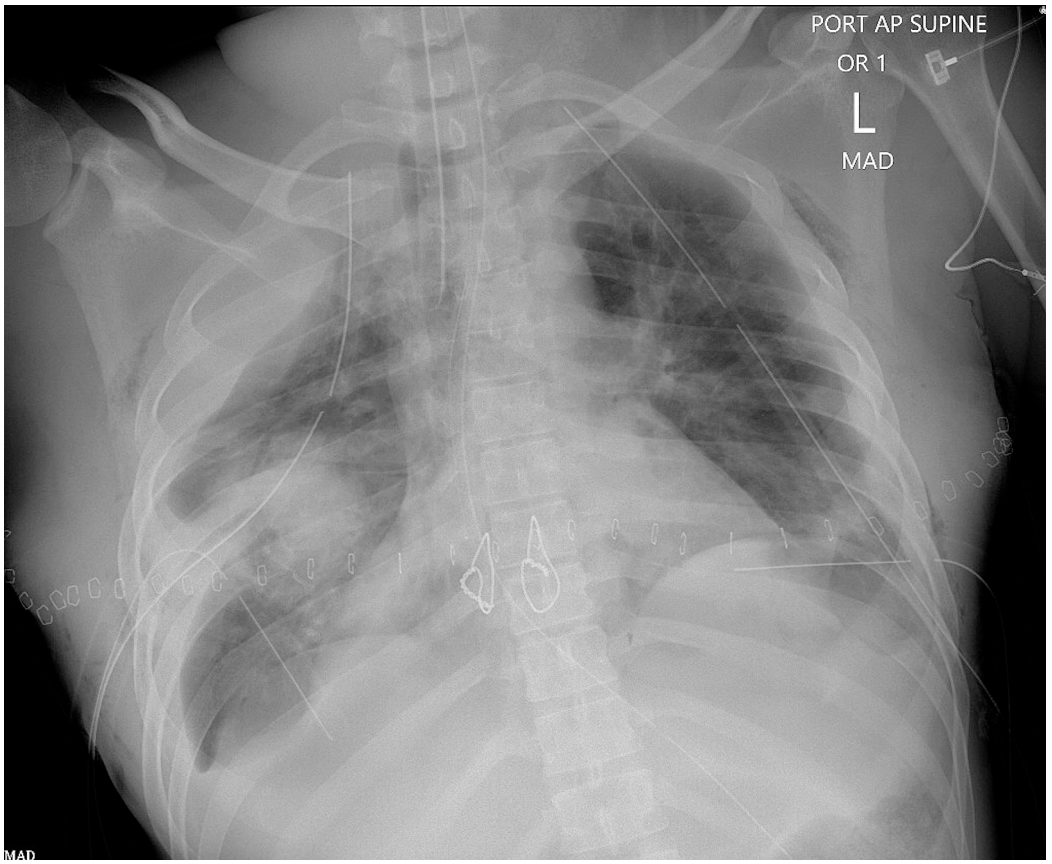

Fig. 1. Postoperative chest X-ray displaying bilateral subcutaneous emphysema and soft tissue swelling of the chest.

emphysema as well as soft tissue swelling in the chest wall.

Postoperatively, the patient was transferred to the intensive care unit in critical condition. Despite continued resuscitative efforts, the patient passed away a few hours later from uncontrollable hemorrhage in the chest cavity in the context of hypothermia, acidemia, and severe trauma-induced coagulopathy. Postmortem autopsy results indicated separation of the left neck muscles with extensive subcutaneous hemorrhage, likely transfused blood products. Unfortunately, the subclavian CVC had been removed prior to investigation by the medical examiner.

Discussion

This case report highlights a rare complication of an initially functional left subclavian CVC, which later infiltrated intraoperatively causing neck compartment syndrome. Compression within the soft tissues of the neck likely stimulated the carotid sinus, a major baroreceptor. Afferent signals are sent through the glossopharyngeal nerve to the nucleus tractus solitarius, causing a reflex bradycardia via increased parasympathetic tone (Fig. 2).

A literature search revealed only one previous report of a similar scenario, in which 500 mL of crystalloid infiltrated from a right subclavian line, causing bradycardia [9]. Notably, in our case, the subclavian line was initially working, as evidenced by improvement in hemoglobin concentration and decreasing acidemia after transfusion with approximately 20 units of packed red blood cells and 20 units of fresh frozen plasma. It was difficult to monitor the patency of the line due to the position of the sterile drapes in relation to the clamshell thoracotomy. It is unclear why, during surgical closure, the catheter retracted and became extravascular. Potentially, manipulation of the chest wall with sternal wires may have caused the sheath to migrate out of the subclavian vein. Additionally, inadvertent traction on the tubing connected to the catheter could have contributed to displacement.

During placement of subclavian lines, the distance from skin to vessel is often at least 35 % of the total catheter length when the needle is inserted at a 45-degree angle [10]. Presumably, blind CVC placement may exaggerate this as the needle is likely to enter the skin at a more acute angle. We recommend cognizance of catheter length when placing any CVC, especially if the line is difficult to monitor intraoperatively due to ergonomics. Furthermore, in such high-intensity situations it could be useful to attach the line more securely to the skin with an additional suture around the catheter itself and not only through the suture eyelet on the catheter hub.

Caution is also warranted when relying on the pressure limit alarm on a rapid transfuser, which is programmed to 300 mmHg as per

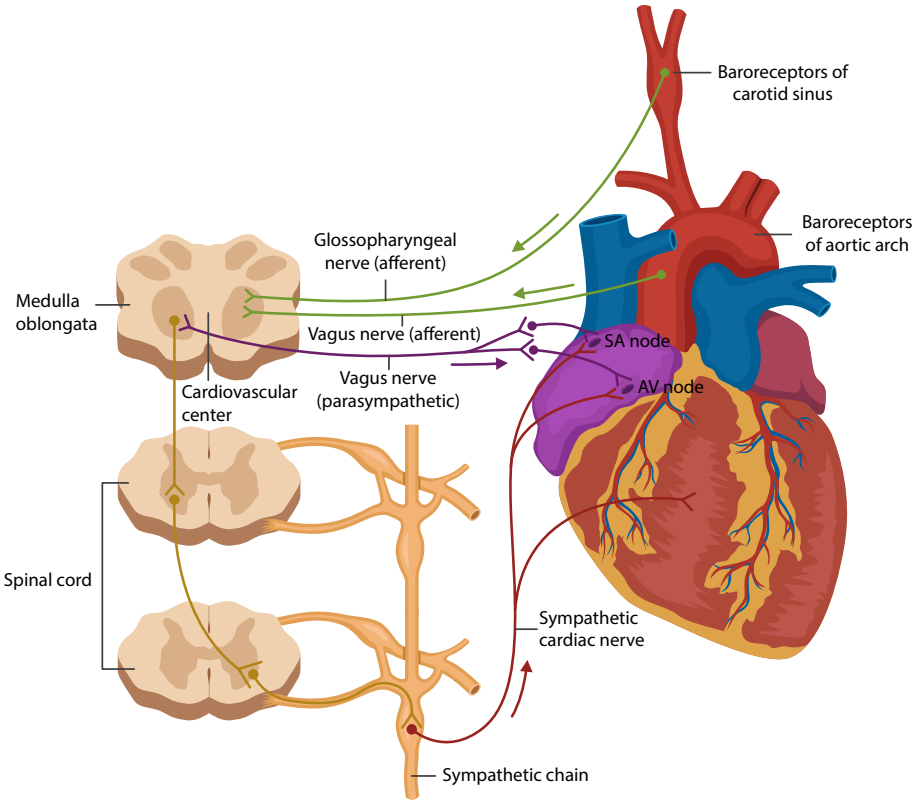

Fig. 2. Schematic of the baroreceptor reflex. Pressure receptors in the carotid sinuses and aortic arch detect changes in arterial pressure. In response to hypertension, afferent signals are sent through the glossopharyngeal and vagus nerves to the nucleus tractus solitarius located in the cardiovascular center of the medulla oblongata. Efferent signals are then transmitted through the parasympathetic component of the vagus nerve, causing bradycardia and decreased contractility.

factory settings. Pressures this high would likely only be reached if the infusion tubing was kinked, occluded, or connected to a small bore IV. The device will, therefore, continue to infuse interstitially without warning, as demonstrated by our case.

CRediT authorship contribution statement

Taylor B. Bucyk: Writing – review & editing, Writing – original draft, Conceptualization. **Caitlin R. Collins:** Writing – review & editing. **Jeffrey T. Macuja:** Writing – review & editing. **Marissa A. Boeck:** Writing – review & editing. **Jenson K. Wong:** Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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