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Emergent Sternotomy for Management of Cardiac Tamponade and Mediastinal Hematoma Secondary to Iatrogenic Central Line Insertion

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Abstract

Central venous catheters (CVCs) are commonly utilised to gain vascular access for varied clinical indications. These include administering drugs, renal replacement therapy, total parenteral nutrition, poor peripheral venous access, cardiac catheterisation, and transvenous cardiac pacing. CVC is routinely used in haemodialysis patients and is often inserted via the jugular vein.

Keywords: Central venous catheters; renal disease; mediastinal hematoma; cardiac tamponade

Introduction

A 61 years old Malay gentleman with underlying end-stage renal disease (ERSF) and hypertension was admitted for elective left permanent internal jugular catheter exchange for the continuation of dialysis. The procedure was complicated with malposition of the catheter, and traumatic mediastinal and pericardial hematoma causing cardiac tamponade. However, this was not noticed initially by the operator and was only realised post-procedure when the patient collapsed due to hemodynamically instability. Urgent CTA thorax confirmed the diagnosis. Misplaced catheter passed through the inferior wall of the left brachiocephalic vein with the tip lies in the mediastinum. The interventional radiologist performed balloon-assisted removal of the catheter. However, due to expanding cardiac tamponade and persistent bradycardia, emergent sternotomy was done for vessel repair and hematoma evacuation by the cardiothoracic surgeon. Post-operation, the patient's condition stabilised and was monitored in surgical ICU and subsequently discharged well.

Background

Central venous catheters (CVCs) are commonly utilised to gain vascular access for varied clinical indications. These include administering drugs, renal replacement therapy, total parenteral nutrition, poor peripheral venous access, cardiac catheterisation, and transvenous cardiac pacing. CVC is routinely used in haemodialysis patients and is often inserted via the jugular vein. The tip of the catheter ideally should be outside of the pericardial sac and parallel with the long axis of the vein in the post-procedural radiograph. The tip should be at the atrio-caval junction, and it should not abut the vein or heart wall at an acute angle or end-on in order to function adequately.

There are several minor and major complications that may occur during or immediately after placement of the catheter, which include inadvertent arterial puncture, pleural and mediastinal injuries, pneumothorax, haemothorax, and haemomediastinum.Cardiac tamponade (CT) is a rare but important complication that should be detected and treated urgently as it is associated with high mortality. Its' incidence ranges from 0.0001% to 1.4% based on case reports. It has an associated mortality rate ranging from 65% to 100% in adults. The incidence is reported higher among the children (1-3%). However, the mortality rate is lower (30-50%) than adults [1]. The signs and symptoms of CT are nonspecific, and it may arise within a few minutes after CVC insertion or up to five months after placement. This is why there might be missed or late diagnosis of CT, which could lead to the undesired outcome as discuss in some reports [2].

In this paper, we present a report of iatrogenic CT and mediastinal hematoma in a patient who underwent a permanent catheter exchange and its outline its management.

Case Presentation

A 61 years old Malay gentleman with underlying end-stage renal disease (ERSF) and hypertension was admitted for elective left permanent internal jugular catheter exchange for the continuation of dialysis. The patient developed one episode of bradycardia and hypotension requiring IV atropine infusion during the immediate post-procedure period. Vital parameters stabilised, and the event was attributed to underlying significant hyperkalemia. However, the patient developed another episode of hypotension, which progressed to hemodynamic instability and subsequent cardiac asystole. Immediate cardiopulmonary resuscitation followed by medical management of the hemodynamic instability managed to stabilise the patient. A review of the post-procedure chest radiograph revealed malposition of the CVC with the tip seen lying on the left to the spinous process line. Urgent computed tomography of the thorax confirmed the malposition of the catheter. The catheter

was noted to puncture the inferior wall of the brachiocephalic vein, and the tip lies in the mediastinum. It was associated with mediastinal and pericardial hematoma. A multidisciplinary decision to remove the CVC with the balloon-assisted technique by the interventional radiologist in the operation theatre was made. The cardiothoracic surgical team was on standby in case of emergency. Post-procedure, the patient developed persistent bradycardia and hypotension despite on balloon tamponade. Urgent on table ultrasonography performed which revealed there is an expanding pericardial hematoma causing CT. The cardiothoracic surgical team proceeded with emergent sternotomy. The patient underwent hematoma evacuation and repair of the exit puncture wound of the left brachiocephalic vein. Post-operation, the patient's condition stabilized and was monitored in the surgical intensive care unit and discharged a week after.

Investigations

Chest radiograph

Showed the tip of the left CVC was projected on the left of the spinal line at the level of T6 vertebral body. There were minimal widening of the mediastinum with an enlarged cardiac silhouette.

Computed tomography angiography of the thorax

Malposition of the CVC. The catheter had punctured through the inferior wall of the left brachiocephalic vein. The tip lies in the mediastinum in between the ascending aorta and pulmonary trunk at the level of T6 vertebra. There was mediastinal and pericardial high-density fluid with the mean HU of 60 in keeping with haematoma. No other major vascular, lung or heart injury. Low lying left brachiocephalic vein with acute inferior turning noted. The pericardial effusion measures are 2.1cm in maximum thickness.

There was also bilateral pleural effusion (Left more than right) with minimal adjacent basal segment passive collapse consolidation bilaterally.

Echocardiography

Pericardial effusion with grade II diastolic dysfunction and hematoma of the superior wall of right atrium.

Differential Diagnosis

Malposition on the left CVC

Mediastinal and pericardial hematoma

Treatment

Balloon assisted removal of the malposition CVC followed by an emergent median sternotomy, clot evacuation and vessel repair were successfully done for expanding pericardial hematoma causing CT.

Outcome and Follow-up

Post-surgical correction the patient condition stabilises, and the patient was subsequently monitored in the surgical intensive care unit. The patient was allowed discharged a week after the procedure.

Discussion

Central venous access involves placing a large-bore catheter either in the internal jugular, the subclavian or femoral vein. The preferred vein for CVC insertion is in the right internal jugular vein (IJV) due to its straight and short course to the right heart and lower risk of the venous stenosis and thrombosis [3]. It allows for a shorter catheter and a higher flow rate.[4]. The left internal jugular catheterisation is more challenging due to its curved course. Incorrect or suboptimal catheter position is relatively common during placement of catheters via left-sided routes due to the necessity to traverse corners. The left brachiocephalic vein, some 6 cm long, begins posterior to the sternal end of the left clavicle and runs obliquely downwards and to the right, behind the upper half of the manubrium sterni to the sternal end of the first right costal cartilage. Here, it unites with the right brachiocephalic vein to form the SVC. The left brachiocephalic vein may occupy a higher level, crossing the jugular notch and lying directly in front of the trachea. Its angle of approach to the right brachiocephalic vein is also very variable, and this is an essential determinant of the ease of central catheter positioning from the left internal jugular and subclavian routes. The more acute the angle is, the longer the distal section of the catheter needed to be able to traverse the corner and higher the risk of perforation. [5] The anatomical level of the superior vena cava origin and artrio-caval junction, and the length of the superior vena cava vary in adults and children. These normal variations could affect the safety of CVC placement [3]. In infants and older adults, the superior vena cava origin and the superior vena cava–right atrial junction are at relatively lower levels [6].

Successful catheter placement requires not only technical expertise but also awareness of the potential complications. Malposition of the catheter is a relatively common complication (5.01%), which could result in the malfunction of catheters [3]. The tip should lie in the longitudinal axis of the superior vena cava or upper right atrium. It is essential to avoid acute angulation against the wall of the superior vena cava or atrium due to the increased risks of thrombosis, catheter failure, or perforation [5]. Careful placement deep at the artrio-caval junction is essential to prohibit catheter malposition and malfunction. There are cases of catheter retracting out of the right atrium and may migrate as far as the innominate veins after catheter placement in patients with high mass body index [4]. Misplaced catheters have been reported in almost every possible anatomical position such as the unintended vessels, mediastinum, pleura, pericardium, trachea, oesophagus, subarachnoid space, and other aberrant sites [5]. Catheter malposition can be associated with severe consequences and needs urgent management. However, some cases, it could be unrecognised in initial setting resulting in incorrect diagnosis and

delayed treatment as in our patient [2]. Radiologic confirmation of the catheter tip position is an important measure to prevent malposition of the CVC. However, it does not guarantee that no vessel or heart wall erosion or migration had occurred. The CVC position should be reviewed whenever chest X-rays are performed. The backflow of blood through lumens should also be assessed before initiation of fluids or infusion through the catheter.

Any nearby structure is potentially at risk from puncture of the needle, guidewire, dilator, or catheter itself during placement [2]. Perforation of the great veins can occur during catheter insertion (direct damage from the needle, guidewire, or dilator), or at a later time (tip migration through the vessel wall). In our case, we believe that the inappropriate manipulation of the dilator caused the brachiocephalic vein perforation. The lower-lying and hanging like course of the left brachiocephalic vein with acute angulation with SVC, which demonstrated on the imaging, might be the predisposing factor. Mismanipulation of the dilators sometimes can even cause ventricular perforations [7]. Other possible mechanism is kinking of the guidewire, resulting in the misdirection of the dilator or perhaps perforation due to guidewire manipulation. The major complication from accidental puncture is uncontrolled bleeding into low-pressure spaces such as the pericardium, pleura, and peritoneum. The catheter tip inserted through the left side is more likely to impinge on the inferior wall of a left brachiocephalic vein or the right caval wall, especially in cases of unrecognised anatomical variation of major vessels as in our patient. Acute perforation of the brachiocephalic or brachiocephalic-SVC junction can result in CT resulting in sudden hemodynamic decompensation. CT can occur either rapidly or gradually over time, but eventually, results in impaired cardiac output. This has to be distinguished from a pericardial effusion which can be very large but does not necessarily impair cardiac function [6]. Regarding diagnosis, 36% of the CT secondary to CVC placement occur within the first 24 which suggests that the perforation occurred at the time of insertion and not by migration or erosion, and 82% occur within the first week after CVC placement.[8] The symptoms include chest or epigastrium pain or discomfort, nausea, dyspnoea, tachycardia, engorgement of neck veins, paradoxical pulse, hypotension, low ECG voltage, and increased cardiac silhouette[2].The classic Beck's triad (hypotension, muffled heart sounds, and jugular engorgement) is not present in over 29% of cases, and death from cardiovascular collapse may be sudden with ''vague signs/ symptoms[2]. CT should be considered in all patients with CVC, presenting with deterioration in their clinical condition.

The key to therapeutic success depends on early clinical suspicion. Computed tomography could confirm the diagnosis and should be urgently done when the clinical suspicion arises which shows decreased size and deformity of the cardiac chambers (particularly with mass effect on the right ventricle) and flattening of the interventricular septum in the setting of pericardial fluid and/or pericardial wall thickening are highly suspicious for cardiac tamponade[9]. Echocardiography is another imaging modality in confirming the diagnosis due to its advantage of providing detailed structural and functional information about the heart, pericardium and inferior vena cava (IVC) It also allows approach planning for pericardiocentesis [10].

Acute injuries that cause cardiac tamponade with haemodynamic instability highly requires emergent thoracotomy [7]. However, there are multiple options of management of mediastinal hematoma such as endovascular approach, video thoracoscopic approach and the new suggested approach of minimal sternoestomy by Siordia, Juan A. [11].

Learning Points/Take Home Messages

ESP block with a minimal sedation may be used as the main anesthetic technique representing a valuable option in the management of fragile patients who undergo surgery. It's safe and easy to perform without determining any respiratory or hemodynamic impact. ESP block can also be a valid alternative if there are contraindications to practice neuroaxial or paravertebral block, such as coagulopathy or anticoagulant/ antiplatelet therapy; it also provides extensive analgesia with a single puncture.

Declaration of Interest

The authors declare that they have no competing interests.

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