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Perforation of Superior Vena Cava /Azygos Veins juntion Leading to a Massive Hemothorax Requiring Thoracotomy Following Insertion of Tunneled a Haemodialysis Catheter; A Case Report

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ABSTRACT

Vascular injury is a potential complication of central venous catheter (CVC) insertion, often used for dialysis or other procedures, superior vena cava and /or Azygos Veins injuries are a rare but serious complication that can occurs when inadvertent cannulation during this procedures, and damage these vessels. This can lead to significant bleeding and potentially life-threatening complications. Prompt recognition and management are crucial. Here we report such an inadvertent central venous injury requiring thoracotomy following haemodialysis catheter placement along with review of literature and recommendation to prevent such complication.

Keywords

Superior Vena Cava vein, Azygos vein, Haemothorax, Tunneled catheter.

Introduction

Haemodialysis catheter (HDCs) is a thin, flexible tube used to access a patient's blood for dialysis treatment, Hemodialysis catheters are an essential part of kidney replacement therapy. Since 1970s, Central venous catheters (CVCs) have provided central venous access, especially for hemodialysis. In 1976, to secure catheters, the subcutaneous tunnel creation was invented, and later a cuffed silicone catheter was developed for patients hemodialysis [1]. The percentage of end-stage-renal-disease (ESRD) patients using hemodialysis varies depending on several parameters, including the time of pre-ESRD care. According to the 2023 US Renal Data System annual data report, 80% of patients with ESRD receive hemodialysis via catheter [2]. It is typically inserted into a large vein in the neck or chest and threaded to the right side of the heart, it contains two lumens: venous and arterial. Although both lumen in the vein, the "arterial" lumen, like natural arteries, carries blood away from the heart, while 'venous' lumen returns blood toward the heart [3], it is non-Tunneled vrs Tunneled. Non tunneled catheter are typically used for short–term or emergency situation, they can be placed at bedside using Seldinger technique without the need for fluoroscopy. while tunneled catheter, sometimes referred to as permacaths dialysis catheters are widely used for longer-term haemodialysis. are used to provide vascular access until the creation or maturation of a long-term dialysis access, such as arterio venous fistula (AVF) or arterio -venous graft (AVG) [4,5]. They are ideally placed under fluoroscopic guidance into the jugular vein and terminate in the right atrium. And within the tunneled category, there are further distinctions: cuffed and non-cuffed. Tunneled catheters are made of pliable materials such as polyurethane–polycarbonate copolymer or silicone to minimize catheter breakdown, vascular damage, and catheter-related complications.

Polyurethane-polycarbonate copolymers are systematically biocompatible [6]. Common site of catheter placement is placed by puncturing the right internal jugular vein(IJV)in the neck, advancing into superior vena cava(SVC) towards the right atrium of the heart due to straightforward path into SVC. Alternatively, a SVC catheter can be inserted via the right external jugular vein(EJV) if right IJV is inaccessible. If both IJV and EJV are both

not accessible, left IJV can be assessed. However, left IJV access is more difficult than right IJV because of its tortuous course to the SVC [7,8]. The use of these catheters is not without a risk. Some of the catheter related complications may lead to major morbidity and mortality in ESRD patient, Potential complication are infection around the catheter can be a serious complication. It is well known that infection is the most common complication encountered with long term HDC and usually associated with significant morbidity, mortality and hospitalization in hemodialysis patients [9]. Most of these catheter-related blood-borne infections are often the result of colonization from the neighboring skin flora [4].

Subsequently, the tunneled cuffed catheters were developed in which the cuff is intended to form a fibrous tissue that could create a barrier against infection [10,11]. other commonly encountered complications include arterial puncture, pneumothorax, catheter malposition, venous air embolism [12,13] and precipitation of dysrhythmias [4]. also blood clots can form in the catheter reducing blood flow [14,15].

Vascular Injury and Bleeding

The incidence of periprocedural arterial and venous injury associated with HDC placement is relatively low (<1%) but can be life-threatening, requiring emergency surgery when the injury involves lacerations to the superior vena cava or azygos vein, mediastinal vessels, or the right atrium [4]. Large caliber dilator is used for insertion of such catheter which can result in serious vascular injury leading to massive bleeding and haemothorax. On the other hand, the risk of periprocedural bleeding and hematoma formation is higher among those who have coagulopathies, thrombocytopenia, and hematological malignancies, or are using blood thinners. To lower these procedure-related complications, the use of Ultrasonography, fluroscopy guidance during HDC placement is advised, a practice that is associated with better outcomes. In terms of management, post placement oozing at the HDC site can be addressed by manual pressure, Gelfoam pledgets, or placing a simple stitch at the catheter exit. While symptomatic hematomas is usually treated with warm compresses, surgical evacuation is rarely indicated in clinical practice [16,17].

Case Presentation

A 66-year-old male patient known case of hypertension, type 2 diabetes mellitus, IHD, cardio myopathy for 15 years, and with End-Stage Renal Disease (ESRD) for last 7months, on regular hemodialysis, the patient had recent history of elective tunneled dialysis permanent catheterization within the right internal jugular vein 5 days ago. On the second day after the procedure patient started to develop mild right side chest pain and SOB, patient was evaluated by a primary physician in the Haemodialysis Center, chest X ray requested, that shown right side haemothorax and then patient reffered to the ER of Portsudan Teaching Hospital on the 5th Day after catheterization. At that time he was admitted with complaints of respiratory distress, features of uraemia and volume overload, with raised serum creatinine level. In the hospital and within hours the condition deteriorated, symptoms worsen more, patient complained of a shearing right side chest pain and severe shortness of breath. with features of respiratory distress. Pulse oximetry, electrocardiogram and blood pressure (BP) monitoring were started. At this time investigation were; Blood tests showed **TWBC** 4100 mainly neutrophil, **PLT** 152000/l, **HB** 8 g/dL, **blood urea** (126 mg/dl), **serum creatinine** (8,2 mg/dl), **S.Na** (136,3 mmol/l). **S.k** (4,3 mmol/l) **LFT** normal, **RBG** (220 mg/dl), UG clear, **PT** 14, **PTT** 35 **INR** 1. Positive hepatitis B serology test. Vascular injury was suspected and Chest X ray(CXR) antero posterior view requested showed whitening of mid and lower lobe of the right lung field and dialysis catheter in -situ (Figure 1).

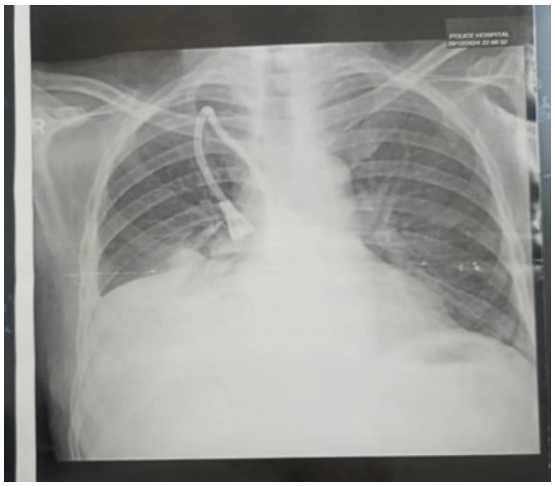

Figure 1: Whitening of mid and lower lobe of the right lung field and dialysis catheter in- situ.

Patient became more tachypneic and hypoxic, so a chest tube was inserted. Rapid drainage of 500 ml of free flowing dark coloured blood in tow minitues, so further drainage stopped to provide optimal resuscitation, and major. This thoracocentesis resulted in some clinical improvement. Femoral catheter was inserted electively, as he needed urgent dialysis. immediate post procedural Chest X ray(CXR) antero posterior view was done to evaluate the condition and showed regressed the haemothorax shadow and dialysis catheter in-situ (Figure 2). Then patient shifted to ICU under close observation.

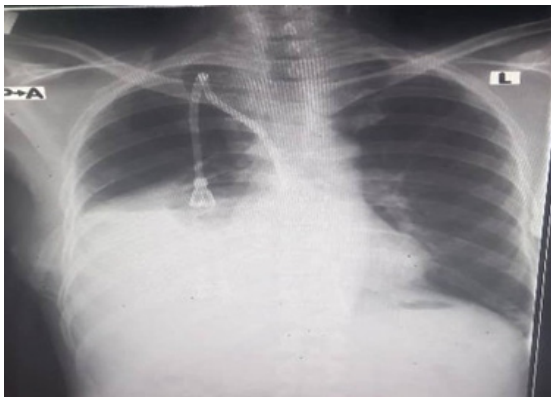

Figure 2: Antero posterior view CXR was done to evaluate the condition and showed regressed the haemothorax shadow and dialysis catheter in-situ.

Post procedural investigation showed drop in **HB** from 8 to 6,4 g/dL, **PLT** dropped from 152000/l to 135000/l **TWBC** 6700 mainly neutrophil **blood urea** (130 mg/dl), **serum creatinine** (8,6 mg/dl), **S.Na** (131 mmol/l). **S.k** (3,5 mmol/l), RBG (259 mg/dl). As the patient was planned for blood transfusion and urgent haemodialysis. At this time High resolution contrast enhanced CT chest requested and shown right catheter noted intimately related to right IJV, SVC and Azygos veins passing posteriorly with tip at D8 level right para vertebral piericing the posterior wall at the junction of SVC and Azygos veins. with right high density pleural effusion and cardiomegaly (Figure 3). Cardiovascular surgery consultation was done and was advised with close observation plus chest tube to avoid a further lung collapse with clinical and radiological follow up. In the ICU. The patient got more unstable with increasing breathlessness, hypoxic respiratory failure, and hypotension. he was resuscitated with fluids and put on oxygen by mask. Routine blood investigations were **HB** dropped from 10 g/dL to 6,5 g/dL, **PLT** 145000/l **TWBC** 8600/l, **blood urea** (112mg/dl), **serum creatinine** (7,1 mg/dl), **S.Na** (135 mmol/l). **S.k** (3,3mmol/l), RBG (188 mg/dl). Repeat chest X-ray revealed complete whitening of the right hemi-thorax (Figure 4). Investigations were sent and cardiothoracic opinion was sought.

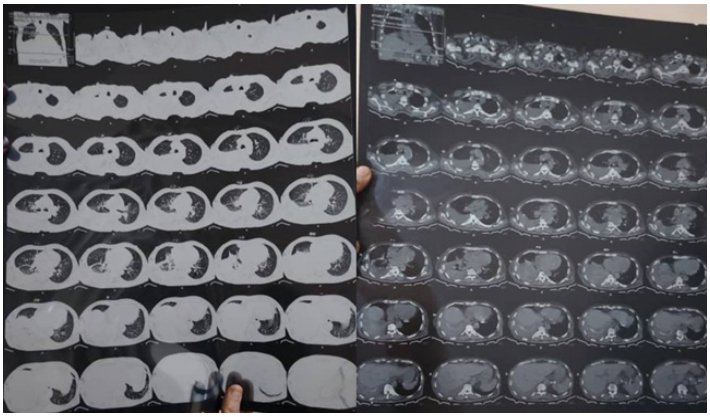

Figure 3: CT chest shown right catheter noted intimately related to right IJV, SVC and Azygos veins passing posteriorly with tip at D8 level right para vertebral piericing the posterior wall at the junction of SVC and Azygos veins. with right high density pleural effusion and cardiomegaly.

A new chest tube was inserted as previous one was not working well. Immediately about 800ml of dark blood drained. Necessitating fluid resuscitation, and prompting a transfusion of red blood cells. Decision of urgent thoracotomy because of suspicion of continued major vascular leak. Through the right-sided lateral thoracotomy approach under general anesthesia and left lateral position, right pleural was opened to track the injury site in the right plural cavity, a large haematoma along with clotted blood was found in the right pleural cavity. which was evacuated and the catheter tip was then found at the right pleural cavity piercing through the posterior wall of the SVC at it is junction with the Azygos vein and causing tear there, the injury site was repaired with 5-0 prolyprolene and the dialysis catheter was removed externally. after proper haemostasis, the chest closed in layer leaving chest drain insitu. After surgery he was shifted back to ICU for observation and mechanical ventilation. he received six packed red blood cells perioperatively and her hemoglobin improved to 10.7gm/dL. Her BP improved and he could be weaned off from inotrope and ventilator. And his post-operative hospital stay were un eventful. Hemodyalysis was started through Femoral Catheter.

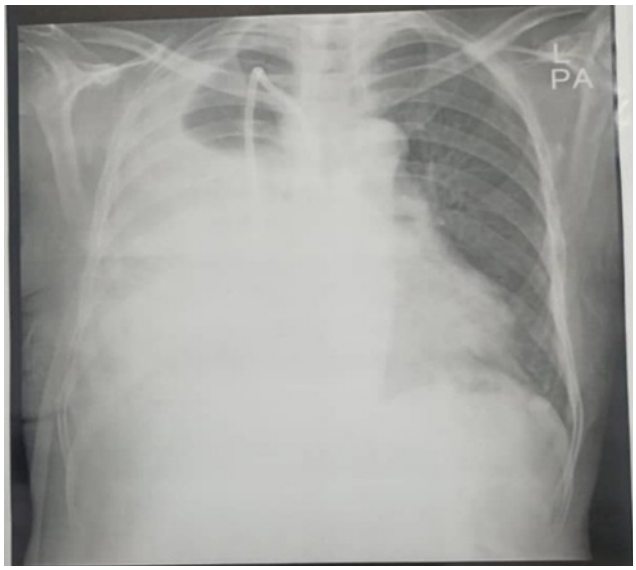

Figure 4: Chest X-ray revealed complete whitening of the right hemi-thorax.

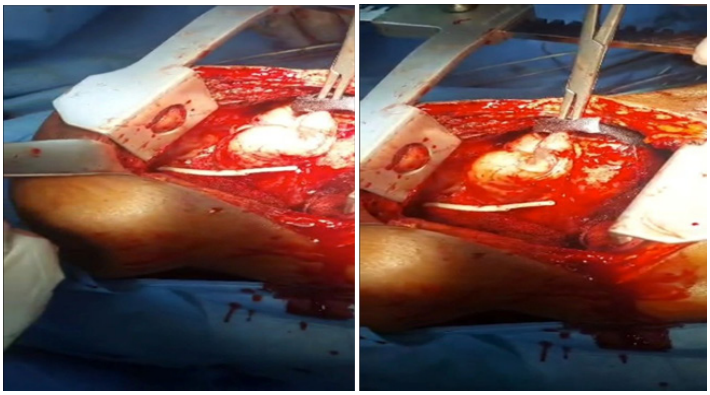

Figure 5: Peri-operative picture showing catheter in the right pleural cavity.

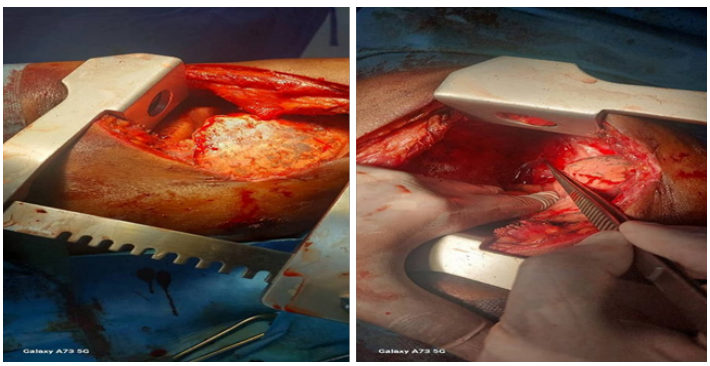

Figure 6: Peri-operative picture showing repaired catheter exit point.

Discussion

Central venous catheter is commonly used to provide access for hemodialysis, when arterio - venous access is not available. They are ideally placed under fluoroscopic guidance into the jugular vein and terminate in the right atrium. common site of catheter placement is placed by puncturing the right internal jugular vein(IJV) in the neck, advancing into superior vena cava(SVC) towards the right atrium of the heart due to straightforward path into SVC [7,8].

Internal jugular vein catheterization is nowadays the preferred vascular access because it is associated to lower risks and complications (15% of mechanical, infectious, malposition or thrombotic complications) [18,19], The most frequent mechanical complications are arterial puncture and secondary hematoma. By contrast, hemothorax and pneumothorax incidence is lower than 0,0.2% and it happens immediately after the puncture [20]. Central venous catheter (CVC) insertion and dilator manipulation can lead to complications like pneumothorax, subcutaneous emphysema, thoracic duct injury, arterial puncture, hemothorax, pericardial tamponade, and mediastinal hematoma [18-21]. In majority of reports hemothorax resulted from arterial injury, and rarely from venous injury due to faulty insertion of needle or catheter, Venous injury is most commonly reported to occur during left sided CVC insertion and arterial injury during right sided CVC insertion [18-21]. In this case, a 66-year-old male patient The patient had recent history of permanent catheter in within the right internal jugular vein 5 dayes prior to presentation. the dilator was blindly and mistakenly inserted to full length, a 19 cm length permanent catheter inserted and then the patient started to developed features of vascular injury in a form of expanding right chest haemothorax from the second day, and the bleeding was venous injury. unlike most of published reports that hemothorax resulted from arterial injury and rarely from venous injury by needle or catheter [22,23], High resolution contrast enhanced CT chest confirmed the catheter tip injury at the posterior wall at the junction of SVC and Azygos veins. injury of these vessels in this patient mostly caused at time of blind permanent catheter placement, particularly when the catheter or dilator is advanced to far or with excessive force, and in some cases, the catheter can erode the SVC vein overtime leading to perforation, the dilator, because of it is stiff texture, can cause vascular injury more severe than a needle or catheter, Safer dilator design and insertion technique have also been recommended to prevent such complication [19]. Azygos vein is a small, collateral vein that drains blood from the thoracic wall in to superior vena cava. Azygos venous system injuries are rare, although not commonly classified as thoracic great vessels, but the azygos system injury particularly the azygoe arch manifists morbidity and mortality that is similar to that of other great vessels injuries, and most of azygos vein injuries are due to penetrating chest trauma [24]. Azygos vein injury during hemodialysis catheter placement is rare reported in 1,2% of cases, but serious complication [25,26], primarily due to inadvertent cannulation during catheter insertion and commonly injured by left internal jugular/or left subclavian vein access or anatomical variations and stenosis of major central veins with collateral cicultion, the catheter tip may accidentally enter the azygos vein, leading to injury or perforation like what happen in this case. The potential risk of incorrect placement of catheter can carries a substantial risk of perforation19%, thrombosis and occlusion. The patients present with features of hypovolemic shock, right-sided hemothorax, and widend mediastinum on chest X-ray due to presence of blood in the mediastinum. and other complication include thrombosis, plural effusion and pulmonary edema have also been reported [24,27,28]. In our case the injuries of superior vena cava and azygos vein were confirmed and inadvertent placement of hemodialysis catheter into azygos vein through the right internal jugular vein is rare and difficult to detect and to our knowledge there were only 4 such cases reported to date [29]. In this case, the patient had undergone elective placement of a 19 cm length tunneled dialysis catheter in the right internal jugular vein, and the Seldinger technique was employed for dilatations over the guidewire, followed by the introduction of an introducer sheath. The catheter was passed through the subcutaneous tunnel, the dilator was blindly and mistakenly inserted to full length, which probably had resulted in venous injury. This is very dangerous maneuver and should never be attempted. Also undue force should never be applied while advancing the dilator. It is important to mention that a long catheter Tips more likely to reach and enter the Azygos vein. This patient had a history of IHD, cardio- myopathy for 15 years and fluids overload in this cardiac patient increased right atrial pressure and can dilate the azygos vein ostium, making it more susceptible to catheter insertion. Direction of dilator advancement is also important as RIJV maintains a medial course while draining to superior vena cava. So the dilator should always be advanced along the course of the vein. Use of real-time sonography or fluoroscopy is recommended especially in difficult cases during insertion of the needle and dilator for prevention of such complication [18,19,30,31]. Venography before or after CVC insertion may help to detect unexpected central venous anomalies, minimize the risk of complications and extravasal placement (as in our case) [18,91]. Postprocedure development of back pain, chest pain or plural effusion can indicate azygos vein involvement. X-ray, CT Scan, ultrasound or echocardiography are recommended to detect such complication [18,22,32,33]. This is specifically indicated if patient complains of retrosternal pain and respiratory distress during insertion or aspiration of blood.

Management of this vascular injury includes stop infusion immediately, confirm location via fluoroscopy, chest X-ray. contrast CT or venography and then either conservative management, or surgical repair via endovascular repair, stent placement, embolization and or balloon tamponade to treat complication [19,23,31]. Emergency thoracotomy like in our case may be needed to remove blood clots, manage hematoma and repair the vascular tear [23].

Rare occurrence of dilator induced venous injury leading to hemo-pneumothorax requiring emergency thoracotomy prompted us to report this case. Itis important to note that from 2005 to June 2025 a total of 12 articles containing 17 cases of misdisplacement of HDCs in to azygos were identified. the majority of misguided HDCs (88,2%) were performed without radiological guidance

[34]. Our purpose to report this case was to notify that this type of misadventure can lead to serious consequences. Inadvertent and blind insertion of large caliber dilator can result in serious vascular injury. Key prevention strategies include using ultrasound or fluoroscopy for precise vein location, avoiding advancing devices against resistance, proper dilater and catheter placement, proper technique and training. Proper site selection as well as addressing coagulopathy, confirmation technique and recognize and treat complication early.

Conclusions

Azygos vein injury during hemodialysis catheter placement is rare, the wide use these catheters in dialysis population and the associated such complications necessitated continuous innovations in the catheter material, design, and placement techniques and a timely open surgical procedure can save patient's life in most cases.

Ethical Statement

All procedure were performed in compliance with relevant laws and institutional guidelines and have been approved by the appropriate institutional committees. Informed patient consent was gained and ethical approval was not required.

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