

# Mediastinal Complications Secondary to Extravasated Peripherally Inserted Central Venous Catheter: A Case Report

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## Abstract

### Background

Peripherally inserted central venous catheters (PICC) are increasingly used in critically ill patients for the ease of access, long-term medication and total parenteral nutrition administration. There is a perception of equivalent utility of PICC lines with a lower incidence of complications as compared to central venous lines. Despite the perception of relative safety, complications can occur.

### Case Presentation

We describe a case of a patient who developed increasing signs and symptoms of sepsis, shortness of breath, and hypoxemia following combined liver and renal transplant 11 days following the initial procedure. Computerised tomography of neck and chest demonstrated pneumo-mediastinum, extensive retropharyngeal and subcutaneous emphysema. The patient returned to theatre on post-operative day 12, for flexible bronchoscopy, video-assisted thoracoscopic surgery and mediastinal washout. Following a further clinical and imaging review, an un-anticipated diagnosis of extravasated peripherally inserted central venous cannula (PICC) as a causative factor of multiple pathologies was made. PICC line was removed. Mediastinal and thoracoscopic examinations were performed and drains inserted. The patient returned to the intensive care unit for ongoing supportive management, with a gradual improvement of sepsis and resolution of mediastinal air distribution.

### Conclusions

Peripherally inserted central venous catheters have an ease of insertion and appreciable favourable health economic outcomes. Recent reviews however have demonstrated an increased risk of catheter tip malposition, in addition to increased risk of thrombosis as compared to central venous lines. Due to the characteristic mobility of these devices, mediastinal and intra-thoracic extravasation of these catheters can occur with consequent severe morbidity. Awareness of the tip position and accompanying clinical and radiological enquiry, must be performed both in the differential diagnosis of chest pathology and prior to use of PICC lines in critically ill patients.

### Background

Peripherally inserted central catheters (PICC) are a widely used form of central vascular access, both

in hospital and community settings. The range of indications is broad, including the need for long-term antibiotics, total parenteral nutrition, chemotherapy treatment, blood products or blood sampling (1)(2). They can be left in-situ for several months (3). In addition to the high utility, these intra-vascular catheters have a favourable economic profile. There is a perception of lower risk of PICC related complications, in comparison with central venous catheters, despite recent meta-analysis demonstrating otherwise (4).

We report a case of a 48 year-old female patient, who during an initial care episode, received a dual liver and kidney transplant for end-stage polycystic disease. With increasing sepsis during the post-operative supportive intensive care admission, computerised tomography of chest and neck demonstrated extensive intra-thoracic air, retro-pharyngeal air, and mediastinitis. During the emergency exploratory procedure to deal with the complications, an un-expected diagnosis of extravasated PICC line as the causative factor of pathology was made. To our knowledge, this is the first case description of an extravasated PICC line causing accumulation of mediastinal air with significant retropharyngeal tracking, and potential airway compromise. Mediastinal complications can have high morbidity and mortality, particularly if not considered or anticipated, in association with the performance of a perceived benign procedure such as insertion of a PICC line. We describe risk factors for PICC line migration, extravasation and discuss a range of potential clinical consequences of this occurrence.

## Case Presentation

A 48 year old woman, day 12 post recent liver and kidney transplant was booked for a diagnostic flexible bronchoscopy, potential trachea-esophageal fistula ligation, mediastinal washout as well as video-assisted thoracoscopic surgery. The clinical course in the lead up to the procedure consisted of a dual liver and kidney transplant 12 days prior for congenital polycystic kidney and liver disease. This was complicated by a placement of a veno-venous bypass cannula into the thoracic cavity with a resultant hemothorax. The liver and kidney transplants were completed uneventfully. The post-operative course consisted of initial uneventful recovery, extubation and monitoring in Intensive Care Unit. Near complete resolution of the right sided haemothorax with CT evidence had occurred and no

residual clinical sequelae.

On day 11 post-operatively she was found to have worsening sepsis, subcutaneous emphysema, voice changes, with shortness of breath. She was increasingly hypoxemic with left sided consolidation and right sided pleural effusion. These symptoms had occurred day 1 following a peripheral central catheter insertion through the left basilica vein. A Computerised Tomography (CT) scan of neck, chest and abdomen demonstrated subcutaneous emphysema in the neck and gas tracking in the subcutaneous region, aetiology of which was uncertain (Figure 1a) and b)). The CT report noted that PICC line was not convincingly intravascular. Left sided supraclavicular tissue streaking was noted. Pneumo-mediastinum was also demonstrated (Figure 2a) and b)). Chest X-ray demonstrated the PICC line in the subclavian vein. (Figure 3). A barium swallow performed demonstrated a communication between the oesophagus and the trachea, indicating the presence of a tracheo-bronchial fistula as a potential causative factor of intra-thoracic infective complication.

Figure 1a) and b): Coronal computerised tomography slice demonstrating extensive pneumo-mediastinum, subcutaneous emphysema in the neck and gas tracking in the subcutaneous region. Arrow demonstrating supraclavicular tissue streaking with related tissue emphysema.

Figure 2 a) and b): Transverse slice demonstrating pneumo-mediastinum and tissue emphysema.

Figure 3: Peripheral intravenous central catheter with the tip in the subclavian vein, Chest X-ray day 11 post initial surgery, day 1 following PICC insertion post initial surgery.

Patient returned to theatre for the planned procedure. Decision was made to maintain spontaneous ventilation during the flexible bronchoscopy, whilst the surgical team examined the trachea with a Storz 6.1 mm flexible bronchoscope. Anaesthesia was achieved with 20 mcg of Fentanyl and sedative dose of target controlled infusion of propofol. Oxygenation was maintained with 30 l/min at 100% Oxygen of Optiflow™ THRIVE during spontaneous ventilation. On examination, no airway fistula was noted by the surgical team. Patient was induced with a modified rapid sequence induction, using 200 mcg of fentanyl, 40 mg of propofol and 50 mg of rocuronium through a peripheral intravenous cannula. Oxygenation during the apnoeic period was maintained with NO-desat technique continuing the Optiflow™ THRIVE at 60 L/min at 100% oxygen and a jaw thrust for ongoing airway patency (5).

Airway was managed with a Mallinckrodt 35 French left-sided double lumen endotracheal tube.

Following a further review of the images, mal-positioned PICC line was queried as a causative factor in mediastinal and thoracic pathology. In addition, a temporal relationship was noted between PICC line insertion, commencement of TPN and the development of mediastinal signs and symptoms. No blood could be aspirated through the catheter. The PICC line was removed from the left basilica vein and sent to pathology for microbial screen and culture. Video-assisted thoracoscopic surgery was performed. Mediastinal washout and drain insertion were performed.

At the completion of surgery, the left sided double lumen tube was exchanged uneventfully over an 14 Fr Cook® Airway Exchange Catheter through the tracheal lumen to a standard size 7 endotracheal tube. The patient returned to intensive care with appropriate sedation and remained intubated until the following day. Resolution of mediastinal radiological signs was demonstrated, as well clinical symptom improvement with resolution of subcutaneous emphysema.

## Discussion And Conclusions

We have presented a patient with mediastinitis, pneumomediastinum, retropharyngeal and subcutaneous thoracic emphysema secondary to an un-anticipated PICC line extravasation. PICC lines, like all medical procedures carry risk. This is often under-appreciated and overlooked in complex patients.

When unanticipated clinical deterioration occurs in a patient, iatrogenic causes must be considered.

In particular, the deployment of any invasive lines including a PICC line, must be carefully and diligently assessed as causative. In this case, complex multi-factorial presentation may have obscured a seemingly benign causative factor, such as a PICC line migration and vessel rupture.

The initial placement of the veno-venous bypass cannula was intra-thoracic, which resulted in acute haemothorax. However, with chest drain insertion and supportive management, this complication had resolved. Our patient was progressing well clinically until the development of infective signs and symptoms, accompanied by shortness of breath and voice changes on day 11. The temporal relationship is fitting, as the PICC line was inserted on day 10 and total parenteral nutrition started at the same time.

In our patient, the Computerised Tomography showed a PICC line tip of uncertain intra-luminal location on day 11 post-operatively. It was beneficial to cease using the PICC line immediately following the radiological and clinical query on post-operative day 11, however no definitive decision as to its removal was made and the PICC line remained in situ. As illustrated in cases where the PICC line had extravasated into the mediastinum, followed by the infusion of high volume intravenous fluid, this can result in a pericardial tamponade with variable mortality reports. From the perspective of the risk of anatomical complications, it was beneficial that the tip of the PICC line was located well outside the pericardial sac, as recommended by a number of authors. The resulting complications of extravasation were therefore less likely to cause a pericardial tamponade.

Pneumo-mediastinum may occur spontaneously or can be secondary, with numerous causative factors such as lung disease, barotrauma, trauma or iatrogenic causes (6). It is recognised through laboured breathing and shortness of breath and can be associated with voice change, retro-pharyngeal air tracking and subcutaneous emphysema. Our patient exhibited all of these symptoms, which resolved gradually with appropriate intraoperative removal of aetiological cause and supportive care in the post-operative period. It is likely that the extravasation of total parenteral nutrition caused the inflammatory changes and creation of air pockets. This pathophysiological pattern has been reported previously by a group of authors, however the severity and anatomical air distribution differed in our case, with greater retro-pharyngeal tracking and potential airway compromise (7).

Mediastinitis can be a challenging diagnosis to deduce as it presents with a non-specific confluence of signs and symptoms. It is often a diagnosis of exclusion with a wide and varied differential diagnosis. Signs and symptoms can consist of chest pain, dyspnea, hypoxemia, neck swelling, difficulty swallowing, dilated superficial and neck veins. Differential diagnosis of mediastinitis consists of number of alternative high morbidity conditions such as aortic dissection, pneumonia, pleural effusions, mediastinal masses or abscess, pericardial effusion or tamponade. The non-specificity of clinical signs and symptoms may lead to a delayed diagnosis or misdiagnosis, which contributes to patients' morbidity and mortality (8).

Recommended site of placement of tip of a central venous catheter is above the level of the right

atrium in the lower or upper superior vena cava, as outlined in guidelines by the United States Food and Drug Administration (FDA) (9-10). In clinical terms, the anatomical level corresponds to the level of the carina, as delineated in anatomical cadaveric and radiographic studies (10). Pericardium crosses the SVC below the level of the carina, with the pericardial sac therefore being below this point (10). This end point of pericardium has been outlined in both anatomical and cadaveric studies (3) (10). By ensuring that the tip of the PICC is above the level of the carina, the risk of pericardial tamponade due to vessel rupture can be minimised. A small number of authors recommend that the peripherally inserted central venous catheters should be located at the junction of superior vena cava and right atrium. This is controversial as it may lead to cardiac rupture and tamponade (9). It is recommended for the tip not to abut the vein or the heart wall at an acute angle, as incidence of perforation increases as the degree of perpendicular orientation of the catheter with the wall of the superior vena cava increases (10)(11).

In our patient, the presence of the PICC line was confirmed with a plain chest radiograph on the day of the insertion to be in the left sided subclavian vein. This is not considered an ideal location by some authors including the USA FDA. Other authorities however consider as large a vessel as possible outside the pericardial sac typically the superior vena cava as acceptable location (12). Subclavian vein location, as opposed to a larger vessel such as superior vena cava, may have been a contributing factor to the extravasation due to vessel erosion by the hypertonic total parenteral nutrition solution. Peripherally inserted Central Venous catheters are known for their potential to migrate with arm movement. In a cadaver study, it was demonstrated that the antecubital PICC lines can advance up to 7 cm with abduction and elevation of the arm (13). An in vivo study found a lower but significant degree of movement with 58% of PICC lines advancing 2 cm or more with arm abduction (14). Haygood et conducted a retrospective review of central lines which had migrated into the azygous vein. Four of these catheters were PICC lines, all of which were inserted through the left side (15). Left sided catheters may also be more likely to result in vessel rupture. When a left sided catheter is not inserted far enough, the catheter tip is more likely to be positioned at a perpendicular angle to the vessel wall, resulting in a compromise of structural wall integrity (16)

PICC's are being increasingly used in critically ill patients. The insertion site is perceived to be of lower risk as it minimises the risk of pneumothorax, haemothorax and can be used with greater degree of safety in coagulopathic patients. Some authors suggest that PICC lines may be more favourable in patients with severe cardiorespiratory abnormalities and morbid obesity (17).

Challenging the clinical perception that peripherally inserted central venous catheters may be safer as compared to central venous lines, a recent review found that malpositioning of the catheter tip, thrombophlebitis and catheter dysfunction were more common than with central venous lines (18). In a meta-analysis of 11 studies comparing the risk of deep vein thrombosis related to PICCs with that related to CVCs it was shown that PICCs were associated with an increased risk of deep vein thrombosis (OR 2.55, 1.54-4.23,  $p < 0.0001$ ) but not pulmonary embolism (no events) (4). The association was particularly strong in critically ill patients and those with a malignancy.

In a prospective cohort study of PICC catheters in neonates, a 1.5% incidence of cardiac tamponade was found among the 194 patients who had this type of catheter inserted routinely. The authors concluded that the association of pericardial effusion with a PIC catheter is a rare but extremely serious event, requiring the use of bedside echocardiography (19). To our knowledge there has been no known, equivalent study performed in adult population.

Cardiac tamponade is more frequently associated to central venous catheters inserted through a peripheral vein, rather than those placed directly in a central vein (20). There are other rare serious complications associated with PICC lines such as catheter fracture and arrhythmias. This is attributed to the mobility and migration of peripherally inserted central venous catheters. There have been literature reports of pericardial tamponade due to the presumed migration of a peripherally inserted central venous catheter (21). In a 20 year-old patient, the tip of the PICC line was identified within the right atrium, migrated and resulted in cardiovascular arrest due to the extravasation of potassium into the pericardial fluid from the PICC. In a 14 year-old patient, where a PICC insertion was approached from the left ante-cubital fossa, cannulation of the right pericardiophrenic vein led to the development of cardiac tamponade (22).

We have reported on delayed migration of a peripherally inserted central venous catheter into the

chest cavity as a causative factor for extensive retropharyngeal and subcutaneous emphysema, pneumo-mediastinum, as well as mediastinitis in a patient with a recent dual liver and renal transplant.

Although there is a perception of relative safety of PICC lines in critical care patients, this is being challenged by recent systematic reviews demonstrating increased risk of deep venous thrombosis compared to central venous catheters. In addition, there is a high frequency of PICC line malposition and migration, which is associated with malfunction and potential vessel rupture. Although rare, vessel rupture can result in mediastinal complications with associated morbidity and mortality if unrecognized. Migration, misplacement and potential catheter pericardial migration need to be considered in the differential diagnosis of intra-thoracic pathology including pneumo-mediastinum with retropharyngeal air tracking, subcutaneous emphysema, mediastinitis, pleural complications and pericardial tamponade.

This clinical and radiological enquiry should be performed both as part of a differential diagnosis and prior to PICC line use in critically ill patients.

## List Of Abbreviations

PICC ( Peripherally Inserted Central Venous Catheter), CT ( Computerised Tomography), TPN (Total Parenteral Nutrition)

## Declarations

### *Ethics approval and consent to participate*

Due to the nature of this retrospective clinical case report individual patient consent was obtained, and ethics committee approval was waived.

### *Consent to publish*

The patient has provided a written informed consent for the publication of this case report.

### *Availability of data and materials*

All images and data generated or analysed during this study are included in the published article.

The content of this manuscript has not been published or submitted for publication elsewhere.

### *Competing Interests*

The authors declare that they have no competing interests.

The author has no financial or non-financial disclosures to make.

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### *Authors Contributions*

Dr Ana Licina contributed to the clinical care and the entirety of the manuscript.

Dr Arya Gupta contributed to the clinical care of the patient, data and image collection and editing of the manuscript.

Dr Andrew Silvers contributed to the discussion and editing of the manuscript.

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### Figures

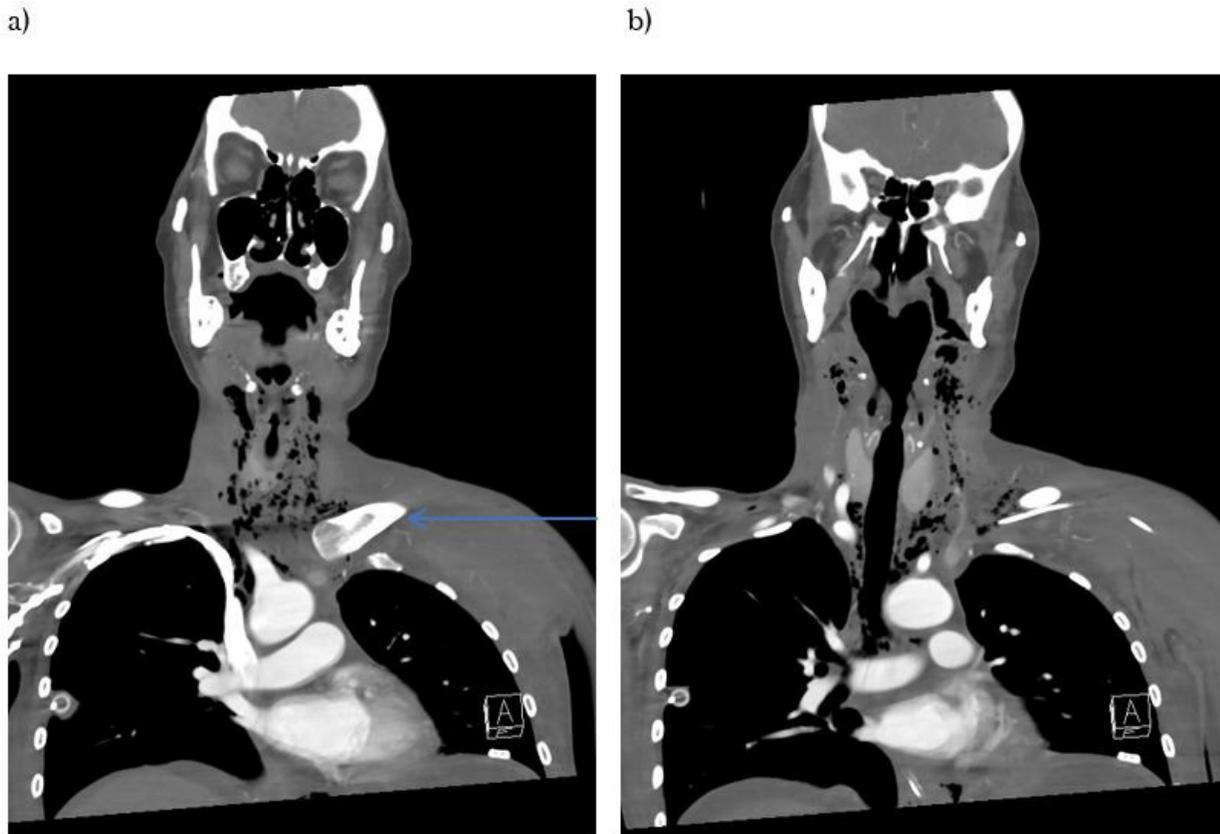
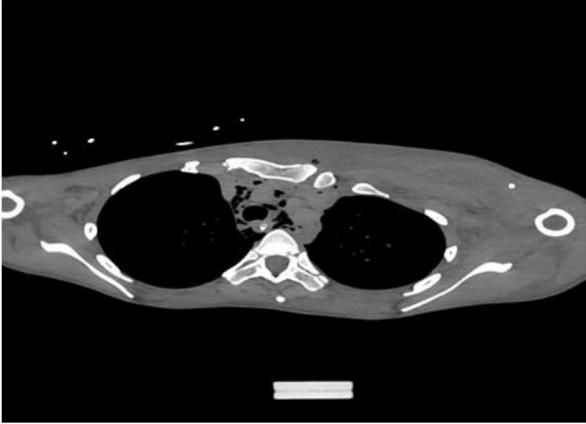


Figure 1

Coronal computerised tomography slice demonstrating extensive pneumo-mediastinum, subcutaneous emphysema in the neck and gas tracking in the subcutaneous region. Arrow demonstrating supraclavicular tissue streaking with related tissue emphysema.

a)



b)

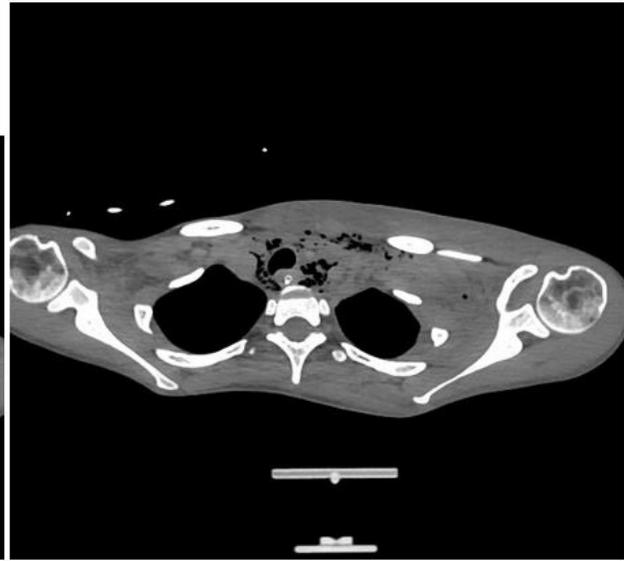


Figure 2

Transverse slice demonstrating pneumo-mediastinum and tissue emphysema.



Figure 3

Peripheral intravenous central catheter with the tip in the subclavian vein, Chest X-ray day 11 post initial surgery, day 1 following PICC insertion post initial surgery.

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