Placement of a peripherally inserted central catheter into the azygous vein

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Abstract
Peripherally inserted central catheters (PICC) are used for a variety of infusion therapies. They are indicated in patients requiring long-term venous access. Incorrect positioning of the insertion of a PICC line is one of the known complications when inserting the device in clinical practice. Radiographers once performing imaging will commonly check if the tip of a PICC has entered the superior vena cava. This case study will report on a lesser known incorrect placement of a PICC line into the azygous vein and how this can be detected on radiographic imaging. This outcome for the patient can be detrimental as it has an increased risk of perforation, thrombus, and fistula formation.

Case Study
An 87-year-old female presented to The Prince Charles Hospital medical imaging service requiring insertion of a peripherally inserted central catheter (PICC). The purpose of the device was to infuse antibiotics in the long term. The catheter was inserted by an operator who was a radiographer sonographer, credentialed locally in performing the procedure. The catheter’s tip position was confirmed by a radiology registrar prior to discharge from medical imaging (Fig. 1). Two hours following the procedure, a second read of the fluoroscopic imaging was performed by an interventional radiology consultant who reported the PICC tip position in the azygous vein. The patient was recalled and under fluoroscopic imaging the catheter was retracted to the distal superior vena cava (SVC) (Fig. 2).

Technique
Prior to commencing the PICC insertion procedure, previous imaging was reviewed, a verbal discussion between the operator and patient occurred explaining the procedure, confirming it was the correct procedure and provided the patient with a final opportunity to ask questions.

The patient was placed in a supinated position on a fluoroscopy table, with the left arm abducted laterally and placed supine on an arm board. A tourniquet was positioned as close to the axilla as possible and the deep veins of the arm were sonographically assessed with a high frequency linear transducer from cubital fossa to the axilla (tourniquet). The patient’s basilic vein was selected for the cannulation site.

A sterile pack including basic procedural ancillary equipment was used along with a sterile pre-packaged PICC line kit. The operator employed personal and procedural protective equipment including lead gown, face mask, hair cap, 5 min aseptic hand wash, sterile gown and sterile gloves. Aseptic technique was employed for the procedure, with the patient’s upper limb prepared using a SOLU-I.V.MD maxi swabstick, containing 2% chlorhexidine gluconate in alcohol. A fenestrated sterile
The procedure required administration of 1 mL 1% lignocaine, which was infiltrated at the level of the cannulation site into the subcutaneous fat layer under ultrasound guidance. A modified Seldinger technique was employed to insert a 5Fr Arrow® (Arrow International, Reading, PA) double lumen pressure injectable PICC line into the venous system under ultrasound guidance. The PICC line was advanced blindly 45 cm and then fluoroscopy used to position the tip of the catheter in the SVC. A radiology registrar confirmed the catheter’s tip position in the SVC and the procedure was completed by securing the PICC with a catheter stabilization device called a Statlock® (BARD, C. R. Bard, Inc., Covington, GA), applying sterile dressings to the puncture site region and flushing both lumens of the catheter with normal saline. No immediate complications were reported and the procedure length was ~30 min.

**Discussion**

Peripherally inserted central catheters are used for a variety of infusion therapies. They are indicated in patients requiring long-term venous access including antibiotics, chemotherapy, total parental nutrition or in patients with poor venous access.1 Numerous complications encountered in PICC insertions are reported in the literature, with the most common types being vascular in nature, such as haemorrhage and thrombus formation; and infection of both the catheter line and the skin puncture site. Intraluminal and extraluminal occlusion causing malfunction and catheter malposition are also reported complications.2

Optimal catheter position described in the literature is with tip placement in the distal third of the SVC.3 Ideally and more precisely, it is at the location of the cavoatrial junction. It is practice at our institute that a PICC line tip position is checked by performing either a chest radiograph, or with the use of fluoroscopy image, such as that produced by a dedicated room outlined above. In our practice once an image has been obtained by the radiographer sonographer, the operator would ascertain if they believed the catheter had been advanced successfully to the distal third of the SVC. Medical officer confirmation is then obtained prior to the catheter’s use as per local protocol. It is not unusual for the radiographer sonographer to manipulate a catheter that was initially advanced into a jugular, either subclavian, axillary or peripheral arm vein segment during a PICC insertion procedure. In some circumstances a hand injection of intravenous contrast is required to map or describe vasculature to assist optimal tip position.

Malposition of a PICC line tip has been reported to cause serious central complication including cardiac tamponade, air embolism, pneumothorax, haemothorax, hydrothorax, thoracic duct injury and extraluminal occlusion.2
The azygous vein, meaning unpaired, is one of the seven veins of the thorax. It originates opposite the first or second lumbar vertebra, courses to the right of the vertebral column and arches ventrally over the superior aspect of the right main bronchus just distal to the level of the tracheal bifurcation. The azygous terminates in the SVC. Many veins drain into the azygous including the hemiazygous vein.\(^4\)\(^5\)

The inadvertent placement of a catheter into the azygous vein is reported as rare. Although an azygous catheter tip placement is recognized as an alternative in some patients with co-morbidity such as severe venous occlusion, the azygous is more susceptible to complications.\(^6\) It is proposed that due to the smaller calibre of the vessel (6–8 mm) there is a greater risk of thrombus formation, perforation of the vessel, stenosis and extravasation.\(^3\)

Reports in the literature describe a small number of risk factors that increase the likelihood of catheter preferential course into the azygous vein. Factors include any condition that increases right atrial pressure. These conditions can in turn significantly dilate the azygous vein calibre allowing a more easily accessed course.\(^6\) This risk factor is particularly relevant for our institute as it is a tertiary referral centre for cardiothoracic care. Haygood et al. reported that a PICC is also more or less heading in the direction of the azygous vein when being inserted from the patient’s left side due to human anatomy. They proposed a decreased probability of azygous placement if a right-sided approach is used.\(^5\)

Performing an anteroposterior chest image such as an x-ray or fluoroscopic image can indicate a high probability that the PICC has entered the azygous vein. Pua states that tracheobronchial angle or the location that the trachea bifurcates to right main bronchus is the precise location of the azygous vein arching over the right main bronchus to enter the SVC.\(^6\) Therefore, a PICC line would be seen tracking laterally at the level of the trachea bifurcation, with an acute angle back towards the midline. The course (of catheter) would then continue medially across the midline of the spine as it heads caudally. Pua reported a degree of catheter foreshortening or ‘catheter kink’ in a case of azygous catheter placement.\(^6\) Our case study demonstrated that catheter foreshortening was not evident and that the initial lateral course of the catheter, followed by a medial and caudal course, was an indicating sign.

In our practice it is commonplace to use a PICC kit that has a limiting catheter guide wire/stylet length such as 70 cm. At this length it may be unable to initially trouble shoot for suspected azygous tip placement during an insertion procedure. We have found that with significant length of wire a brief test for projecting the course of catheter can be performed assessing the projected course. If the wire can be demonstrated coursing either below the diaphragm and right of midline (inferior vena cava) or into the cardiac shadow while remaining above the diaphragm, one can more confidently rule out a suspected azygous placement. Furthermore, a hand injection of radiopaque contrast media during the insertion procedure can be used to delineate vessel anatomy as an alternative to a wire-based trouble shooting approach.

Highly accurate diagnostic information regarding PICC line tip malposition can be acquired with cross-sectional imaging such as computed tomography. Haygood et al. report diagnosing a central venous catheter with the tip position in the azygous vein.\(^5\) However, as a frontline PICC check modality, it is the opinion of the authors of this paper that this may not be cost-effective or as timely as a ‘during procedure fluoroscopic imaging’.

**Conclusion**

Knowledge of venous anatomy beyond the major vessels of the deep system in the upper limb is invaluable. Azygous vein anatomy and image interpretation of suspected azygous catheter placement should be highlighted to all healthcare professionals with a stake in quality PICC line placement. Malposition of a PICC line should be corrected to reduce potential serious central complications.

**Conflict of Interest**

The authors declare no conflict of interest.

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