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THE EVALUATION OF CORRECT PICC POSITIONING IN RADIOLOGICAL IMAGING OF THE CHEST

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PICC (Peripherally Inserted Central Catheter), Central Venous Catheter (CVC), posterior-anterior (PA), latero-lateral (LL), radiography (RX).

Abstract

Central venous catheterization (CVC) represents a very common procedure in medical practice. In fact, the CVC is used for central venous pressure measurement, fluid administration, chemotherapy, parenteral nutrition, and extracorporeal therapies. In literature, the ideal placement of CVCs is the atrial cavo junction, in the distal 1/3 of the superior vena cava, or in the proximal 1/3 of the right atrium. The Peripherally Inserted Central Catheter (PICC) is a 40-60 cm long peripherally inserted central venous catheter with an average length of stay of more than 30 days. It is a medium- to long-term central venous device that allows for safer infusion of prolonged and/or intermittent therapies with drugs that would otherwise be injurious or toxic to small-caliber veins. International guidelines recommend always checking the correct placement of the CVC tip and identifying possible complications before its use. Chest radiography represents in clinical practice the most widely used technique for checking CVC placement in the veins of the upper caval district and possible early complications related to placement.

ESSAY

Introduction

Central venous catheterization (CVC) represents a very common procedure in medical practice (Fig. 1). Indeed, CVCs are used for central venous pressure measurement, fluid administration, chemotherapy, parenteral nutrition, and extracorporeal therapies. In the literature, the ideal placement of CVCs is the atrial cable junction, either in the distal 1/3 of the superior vena cava or in the proximal 1/3 of the right atrium (Fig. 2). The PICC is a peripherally inserted single-lumen central venous catheter made of silicone or PUR, which is flexible, soft, biocompatible, 40-60 cm long, with an average length of stay of more than 30 days. It is a mid- to long-term central venous device that allows for safer infusion of prolonged and/or intermittent therapies with drugs that would otherwise be injurious or toxic to

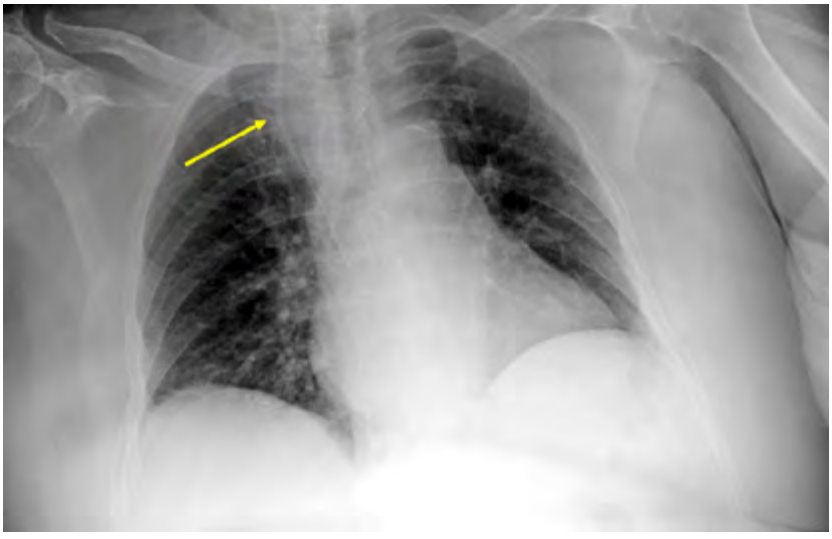

***Fig.* 1.** *Chest AP x-ray (bedridden patient) showing the presence of CVC (arrow)*

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small-caliber veins (e.g., cancer chemotherapy) and special procedures (dialysis, feresis, etc.). It is placed by puncturing a superficial vein in the elbow crease, or by ultrasound retrieval of a deep vein in the arm (basilic v., brachial v., cephalic v.) using a high-frequency probe (7.5-9 MHz) with introduction of a microguide. It can remain in place for up to a maximum of 6 months. Measurements are expressed in French (Fr) to indicate outside diameter, in Gauge (G) to indicate inside diameter, and in cm to indicate length.

The advantages of using the PICC are:

- It is a venous access, into a large caliber vein, which allows the administration of drugs that if injected peripherally could cause tissue damage to the vein itself or to the arm;
- It reduces the risk of infection;
- It reduces the risk of venous thrombosis;
- Its use is permitted in both hospital and home settings; - It allows freedom of movement.

PICC placement is, however, contraindicated in the following situations:

- Previous radiation therapy at the planned placement site;
- Previous episodes of venous thrombosis or vascular surgery at the intended placement site;
- Presence of arteriovenous fistulas in the affected limb at the placement site;
- Uncooperative patient;
- Plegic, paretic or immobilized limb due to surgical outcomes, fractures or joint disease;
- Presence of previous mastectomy surgery and/or lymph node dissection; presence of lymphedema.

PICC placement takes place in the patient's bedside. No preparation (such as fasting) is involved. It is a sterile procedure that takes an average of 40-60 minutes. The catheter is inserted in the middle third of the arm, above the elbow, to ensure maximum mobility. International guidelines recommend always checking the correct placement of the CVC tip and identifying possible complications before its use. Chest radiography represents in clinical practice the most widely used technique for checking CVC placement in the veins of the upper caval district and possible early complications related to placement.

The technique for controlling catheter tip placement is called tip-location. The most widely used methods of tip-location are: Chest X-ray (post-procedural) (Fig. 2) and intracavitary ECG (intraprocedural). Radiologic findings, used to determine catheter tip location, may not correspond to actual anatomic findings due to physiologic or pathologic anatomic variations, or due to unclear images or artifacts, thus leading to interpretation errors.

Mispositioning predisposes the patient to complications that may reveal themselves during central venous catheter placement or after time. Mal-positioning can also be asymptomatic. For this reason, if the CVC has not been placed under radioscopic guidance, a radiographic check should be requested immediately after placement. In all cases of mal-positioning, it is necessary to discontinue use of the CVC and arrange for repositioning.

In the presence of acute onset chest pain, dyspnea, agitation, tachycardia, hypoxia, a chest X-ray should be performed to rule out the presence of a pneumothorax.

Technique of performing chest radiography:

Chest radiography is performed in two standard projections: postero-anterior (PA) and latero-lateral (LL). Chest radiography does not require any specific preparation. While performing the examination,

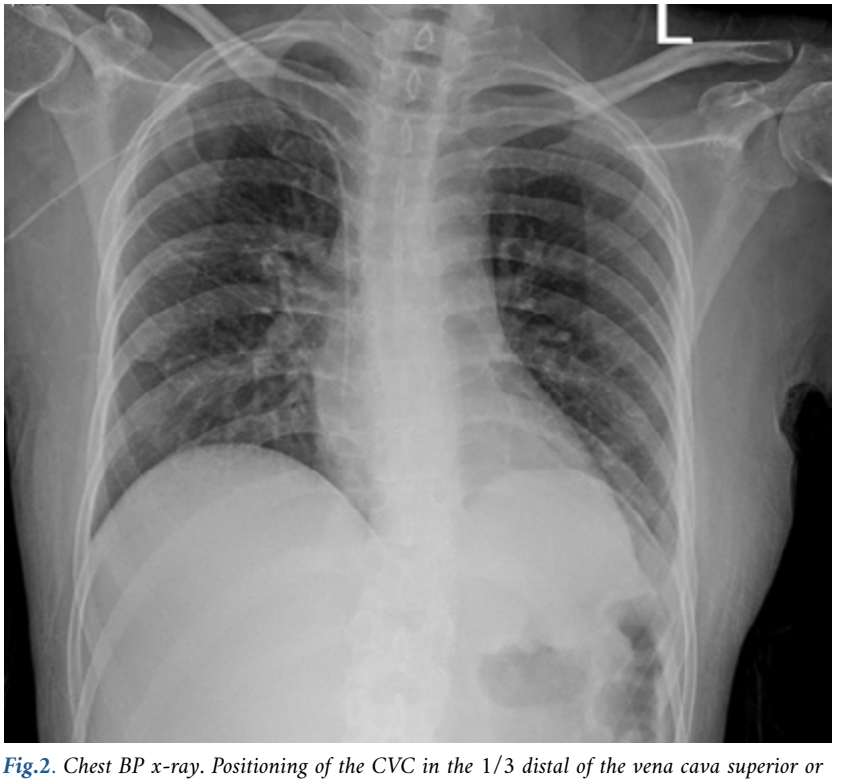

***Fig.2**. Chest BP x-ray. Positioning of the CVC in the 1/3 distal of the vena cava superior or in the proximal 1/3 of the right atrium.*

the patient is asked to remove any metal objects on the thoracic region such as chains, piercings or the bra in the case of female patients, which may alter the radiographic image.
The postero-anterior or dorso-ventral projection (Fig. 3) is performed, if possible, in orthostatism. The anterior part of the chest rests on the sensitive plane, while the hands should be placed with the back on the hips and at the same time a forward thrust of the elbows is exerted to prevent the image of the shoulder blades from overlapping with that of the lung parenchyma. The incidence of the main beam should be approximately at the level of the 4th/5th dorsal vertebrae and perpendicular to the sensitive plane and the center of the cassette. The collimation of the radiation beam should coincide scrupulously with the width of the cassette to minimize flou from secondary radiation. The radiogram is performed in deep inspiratory apnea. In this respiratory state, the greatest expansion of the lung fields, the greatest lowering of the hemi-diaphragms and the greatest deepening of the basal lung recesses are realized. In correct inspiratory apnea, the diaphragmatic domes should project below the IX costa (posterior reference) or below the anterior arch of the VI costa. The lung fields must be fully represented, from the apices to the lateral costo-phrenic sinuses. The two hemithoraxes must be symmetrical with equal distance between the sternoclavicular joints of the two sides and the spinous apophyses of the dorsal vertebrae.
In the latero-lateral projection (Fig. 4), the patient in orthostasis, where possible, raises his arms upward while holding his elbows or forearms with his hands, discreetly raises his head, and rests his left flank for the greater proximity of the heart to the sensitive plane and, therefore, to reduce the magnification of the cardiac shadow. The beam cuts perpendicular to the sensitive plane on the flank at the level of the 6th dorsal vertebra. The examination should be performed in deep inspiratory apnea. The lung fields should be fully imaged, including the posterior costo-phrenic sinuses.

Conclusions

This study, which is descriptive in nature, aims to explicate the performance of chest radiography and the criteria for evaluating proper PICC implant placement. The radiologic method, while allowing reliable assessment of tip placement after implantation, is associated with a greater expenditure of resources: of the technician performing the radiologic examination, the radiologist reporting the examination, the use of the x-ray machine, and the possible transport of the patient to the Radiodiagnostic service. To this, the patient's exposure to ionizing radiation must be added, which makes the procedure unsuitable in some individuals (e.g., pregnant women).
The radiologic findings used to determine the position of the catheter tip may not correspond to the actual anatomic findings due to physiologic or pathologic anatomic variations (such as, atrial enlargement or presence of congenital anatomic variants). Chest radiography, however, is still used, along with intracavitary ECG, for evaluation of PICC placement.

Fig.3 *Chest x-ray. PA Projection*

Fig.4 *Chest x-ray. LL Projection*

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