Can Peripheral Central Venous Lines be inserted safely and successfully where X-ray facilities are not available?

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Abstract

Background:
Primary care settings often lack facilities for radiological evaluation of the position of supra-and infra-clavicularly inserted central venous catheters. If peripherally inserted central venous lines could reliably be successfully inserted this would make the need for immediate confirmatory radiological studies less crucial. Previous studies with peripherally inserted catheters reported a low success rate. This study was performed to determine whether the placement of a more flexible peripherally inserted catheter, the Arrow PICC (Arrow PS-01651), would result in an improved and acceptable success rate.

Method:
Twenty-three patients in the casualty unit of the Mamelodi Hospital during 1997 and 1998, who required a central venous line and had this inserted via the peripheral venous route were evaluated after insertion of the catheter. The best basilic or median cubital vein in the cubital fossa was used for insertion following a standardized method. A number of 14 catheters were inserted in the right arm and 9 were inserted in the left arm. The position of the placement was assessed by an AP supine chest X-ray.

Results:
Successful placement was achieved in 91% of insertions (21 of 23 catheters).
In both of the unsuccessful placements the catheter tip was located in the ipsilateral internal jugular vein. (One on the left and one on the right.) No clinically significant complications resulted from these procedures.

Conclusions:
This study showed that central venous catheterisation with soft catheters (ArrowPICC- Arrow PS-01651), via visible palpable peripheral veins in the cubital fossa is easy to perform and is a safe procedure with a high success rate for correct catheter placement. This route warrants serious consideration when central venous catheterisation is desirable, especially in settings where X-ray facilities are not available to exclude complications or confirm placement.

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Introduction

Central venous lines are used for the accurate monitoring of fluid administration in various clinical settings[1]. It is extremely valuable[2], but correct placement is essential for accurate monitoring.

Insertion is usually effected via the supraclavicular or infraclavicular routes. Complications, such as pneumothorax, hemothorax, catheter embolism, venous air embolism, nerve injury, arterial puncture and chylotho-

rax, have all been documented following catheter insertion via these routes[3].

In an article discussing complications associated with central venous catheters, Scott states that a "Chest X-ray is mandatory to exclude immediate complications for e.g. a pneumothorax"[4]. Strong warnings appear in the package insert of these central venous catheters, advising that it should not be done without X-ray control. (e.g ARROW product no AK-04650-E 8/92). Even standard textbooks1 make the point that this procedure is potentially dangerous and requires adequate assessment.

These guidelines and the weight of evidence concerning complications are a major deterrent to doctors inserting central venous lines when no X-ray facilities are available.

The insertion of supra- or infraclavicular central venous lines also requires special instruction and frequent use to maintain the skill and expertise to perform these procedures. Radiological control is often not available in primary care environments, especially after hours.

Rosen[5] has shown that the insertion of central venous lines via the cubital fossa (peripherally inserted central catheters) is safe and has a low complication rate, similar to the insertion of a normal drip. However, previous studies with peripherally inserted catheters reported a low success rate – 77,7% correct placement with a Drum cartridge catheter, and 52,8% with the I-catheter (Bardic)[6].

X-ray assessment following catheter insertion is performed to exclude the complications listed above and to ascertain whether the catheter tip is in the desired position.

Major complications needing X-ray assessment are unlikely to occur following peripheral venous insertion, so the major reason for X-ray assessment is to determine the correct placement of the catheter tip.

If peripherally inserted central venous lines can be successfully inserted (i.e. the catheter tip in the correct position to monitor central venous pressure), the necessity for radiological evaluation is far less critical.

This will be of tremendous help to primary health care doctors without radiological control facilities. Some authors have suggested that a medial cubital vein should be used in emergency conditions to reduce the number of complications[7]. Cannulation of the superficial veins of the arm require less skill than cannulation of the subclavian and internal jugular routes[1].

Peripherally inserted central venous pressure has been shown to reflect central venous pressure quite accurately under controlled circumstances[8]. Rosen[1] argues that for short-term use, central venous catheterisation through visible palpable peripheral arm veins is safe and remains the method of choice for those with little experience of sophisticated techniques. Primary care doctors are not always exposed to and therefore often have little experience with sophisticated techniques. This study was prompted by the fact that Mamelodi hospital has no X-ray facilities after 4 pm in the afternoon and practitioners working there have to deal with many patients who would benefit from the insertion of a central venous line. We believe there are many such settings where primary care doctors have to work in less than ideal circumstances and also have not had exposure to training in the insertion of catheters via the supra- or infraclavicular routes.

If we can find a method with the safety and the lack of major complications that peripheral vein cannulation offers but with an acceptable accuracy of placement of the catheter tip to ensure the benefits of central venous pressure monitoring, this would have obvious benefits.

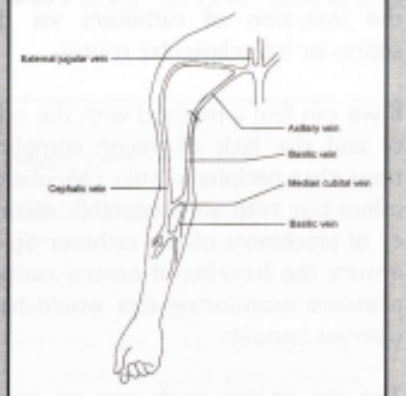
The aim of this study was to determine whether the more flexible Arrow PICC (Arrow PS-01651 Peripherally Inserted Central Catheter) could be safely inserted via a peripheral vein with the catheter tip placed successfully in the desired position in the superior vena cava.

Materials and methods.

The Arrow PICC catheter was inserted in 23 patients needing a central venous line. The Arrow PICC (Arrow PS-01651) is a soft polyurethane radiopaque catheter, 55cm, 16Ga (Figure 1). The study was performed in the casualty unit of the Mamelodi hospital during 1997 to 1998. Informed consent was obtained from all patients or their family prior to insertion of the catheter and the study was approved by the Ethical

Figure 1: The Arrow PICC (Peripherally inserted central catheter) (Arrow PS-01651) with syringe, cannula and catheter (arrow heads).

Figure 2: Figure 2. Anatomy of the superficial veins of the arm.



Committee of the Faculty of Medicine of the University of Pretoria.

A method described by Rosen[5] was used to insert the catheter, which is as follows: The best basilic or median cubital vein of the cubital region on either the left or right side was used (Figure 2). The patient was positioned in a supine position, with the arm abducted 45° and the head turned towards the side of insertion. Patients with suspected neck injuries were therefore excluded from the study. The insertion was performed under sterile conditions. One catheter was inserted by REK and all the others by JMB. No additional training was necessary in advance. The procedure is simply the same as inserting a ordinary 14-Ga Jelco intravenous catheter in the basilic or median cubital vein in the cubital fossa.

The cephalic vein was avoided because of a lower success rate[3], due to the vein coursing through a 90° angle in the deltopectoral triangle and again through the clavipectoral fascia to the axillary vein.

The correct length of the catheter was determined by measuring the catheter in its sterile packing on the patient. The catheter has marked calibrations, which allows for accurate measurement of the length of catheter required to be inserted into the vein. The measurement was estimated from the insertion site in the cubital fossa, following the route of the vein through the arm, axilla, and infraclavicular region, to a point to the right of the sternal angle.

The Arrow PICC(Arrow PS-01651) is a catheter-through-cannula device. The venepuncture is performed using a short needle encased with a cannula (similar to a 14Ga Jelco needle). A syringe attached to the needle can easily detect successful venepuncture (Figure 1). The cannula tip is fairly sharp and rigid to enable it to penetrate the skin and wall of the vein. This allows the catheter that is subsequently inserted through the cannula to be of a much safer material and design. The needle is removed before the catheter is inserted, consequently eliminating the risk of damaging the catheter. The catheter is inserted through the cannula into the vein. After the catheter is inserted the cannula is removed (Figure 3). No resistance is noted on advancing the catheter.

Blood was freely aspirated from the catheter after insertion. When measuring the central venous pressure oscillations, synchronous with the respiration and pulse is observed.
A supine AP chest X-ray (Figure 4) was taken afterwards to determine the position of the catheter tip and to determine any immediate complications.

Figure 3: Removal of cannula (arrowhead) after catheter insertion.

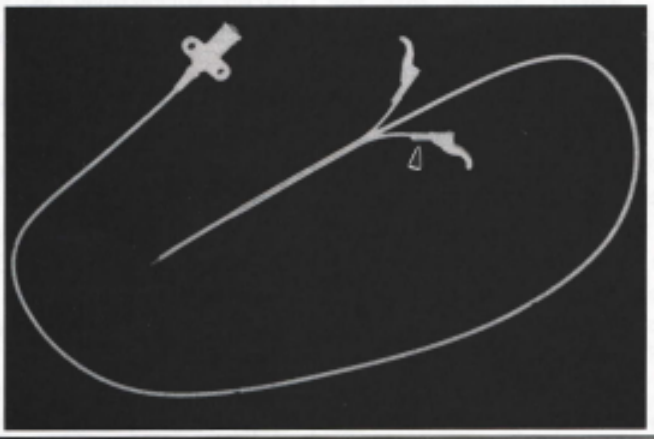
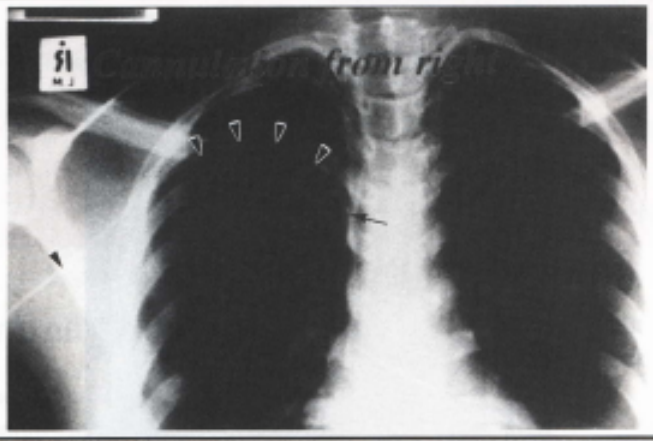


Figure 4: Supine AP Chest X-ray demonstrating the catheter from the right side (arrow heads) and the position of the catheter tip (arrow).



Correct placement of the catheter tip was defined as placement of the catheter tip in the superior vena cava, 3-4 cm above the entry into the right atrium, with the distal portion of the catheter positioned parallel to the vessel wall[10]. The position of the catheter was considered unsatisfactory if it assumed any other position e.g. in a peripheral vein, in an internal jugular vein or in the heart.

A number of 14 catheters were inserted from the right and 9 from the left.

Each patient was followed up after 24-48 hours to check for any complications. All patients were examined clinically.

Results

There were thirteen successful catheter placements in the right arms of patients and eight on the left (Table I). The two unsuccessful placements resulted in the catheter tip lying in the ipsilateral internal jugular vein (Table I). One failure was from a catheter inserted from the right side and one from the left. The mean length for catheters inserted on the right was 38 cm, and on the left 48 cm. No early complications were recorded.

Three patients developed a superficial inflammation at the insertion site after 48 hours. Our success rate for correct placement of the catheter tip was 91%(21 out of 23).

Discussion

This study resulted in a high success rate (91%) and a low complication rate. There were no significant clinical complications and only three patients suffered from superficial inflammation at the insertion site.

One obvious limitation of this study is the number of catheter placements (23) studied when compared to the 94 done by Ng and Rosen6, the 50 used by Burgess[11] and the 50 used by Bridges[12].

However this study was performed in a primary care setting and because the authors performing the study work mainly in an environment where confirmatory X-rays are not available (Mamelodi), obtaining patient numbers where confirmation of placement is possible hampered the recruitment of patients.

In addition this study was performed by primary care physicians with no special training in intravenous techniques. This may have more relevance for other primary care physicians than studies conducted by experienced anaesthetists and intensivists in large centres.

Reasons for the high success rate may be the performance of most insertions by one operator (JMB). No additional training in intravenous technique was however needed, due to the fact that insertion of this catheter in the basilic or median cubital vein is similar to inserting an ordinary 14-Ga Jelco intravenous catheter. One catheter was inserted by another operator (REK) without any problems. Difficulties to insert these catheters are the same for intravenous cannulation and could therefore be performed by any doctor who is skilled to insert intravenous lines.

Table I: Results of catheter placements.

	N	Successful placement	Unsuccessful placement
Right	14	13	1
Left	9	8	1
Total	23	21	2

Care was also taken to adhere to the following principles:

1. It is important to measure the length of the catheter as precisely as possible.
   The position of the catheter is deemed unsatisfactory if it lies in a peripheral vein, in an internal jugular vein, or in the heart. Inserting too great a length of catheter especially from the right may lead the catheter into the right atrium, ventricle or even enter the pulmonary artery[13]. Most frequently mal-positioned catheters inserted through the arm veins find their way to the ipsilateral internal jugular vein. Both misplaced catheters in our study were found to lie in the ipsilateral internal jugular vein.

2. The patient should be in the correct position when inserting the catheter. Woods et al[14] showed that especially when the basilic vein was used, the 45° abducted arm improved the success rate. Dietel and McIntyre[15] found that turning of the head towards the side of venepuncture reduced the chances of the catheter entering the ipsilateral internal jugular vein. The value of these various manoeuvres has been proven with catheters inserted via the basilic vein under fluoroscopic control[16]. These procedures were part of the insertion protocol and were followed with all placements, including the failures.

   If the catheter tip is not correctly placed, central venous pressure can not be accurately recorded. However, no major immediate complications will result and the line may serve as an intravenous line for some hours. The clinical observations we performed, i.e. measuring the venous pressure with the observation of oscillations synchronous with pulse and respiration, did not help us detect the failures.

3. The type of device used appears to be an important factor in determining the success rate of cannulation through arm veins. Studies

show that the more rigid devices like the I -catheter[6] do not demonstrate as high a success rate as the softer more flexible catheters[12]. We used the Arrow PICC which is also a soft type of device. Our success rate supports this statement.

4. Reading of the central venous pressure should be done with the arm in 45° abduction. Further abduction or adduction of the arm can lead to movement of the catheter tip up to 2-3 cm. Adduction alone can result in the catheter being drawn into the thorax as much as 9 cm[17].

There is a risk of air embolism after the syringe is removed and the cannula is situated in the lumen of the vein and the proximal end is open to the atmosphere. This is usually the case with most central venous lines irrespective of their place of insertion. The central veins are however prevented from collapsing because of connective tissue surrounding them. Air embolism is therefore more likely to occur in them than the peripheral veins[18].

Authors have suggested that a medial cubital vein should be used in emergency conditions to reduce the number of complications[7]. Cannulating the superficial veins of the arm require less skill than the subclavian and internal jugular routes[1].

The Arrow PICC is a safe catheter. It is a catheter-through-cannula device. The catheter is not inserted through a needle device. Therefore the catheter cannot shear if attempts are made to withdraw it while the needle is still in the vein. There is no flexible stylet wire stiffening the catheter throughout its length.

Three cases developed superficial inflammation at the site of insertion. None of these three developed trombophlebitis. A superficial inflammation is not an indication to remove the catheter. However if signs and symptoms of severe local infection and systemic infection appear, the catheter should be removed[19]. An aseptic technique should be followed, and the catheter should be removed as soon as it is no longer needed.
Using the PICC Catheter Set (Arrow PS-01651) proves to be cost-effective. The cost of the catheter pack is two thirds of the price of a standard Central Venous Line Catheter Set.

Conclusion

We think that despite our small numbers this study confirms that central venous catheterisation with a soft peripherally inserted intravenous catheter (Arrow PS-01651) through visible palpable peripheral arm veins in the cubital fossa is safe and easy to perform.

It has a low complication rate and a high successful placement rate. Accordingly it merits serious consideration especially in situations where X-ray facilities are not immediately available and a central venous line is considered to be imperative. We would also hope that further studies could be conducted on a larger body of patients to better assess the promise of this technique.

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