Tunnelled Peripherally Inserted Central Catheter - How We Do Them

Poster No.: C-1780
Congress: ECR 2017
Type: Scientific Exhibit
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Keywords: Education and training, Catheters, Ultrasound, Veins / Vena cava, Vascular, Interventional vascular
DOI: 10.1594/ecr2017/C-1780

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Aims and objectives

**Learning Objective:**

To understand the technique of performing tunnelling for peripherally inserted central catheter (PICC) with the view of reducing the risk of catheter infection and thus increasing long-term venous access.

**Background:**

With the advance in new chemotherapeutic regimes, better and easier venous access is becoming critical. To this end, the peripheral implantable port for the arm with simpler placement, fewer complications and, in some series, greater patient acceptance has been developed as an alternative to the centrally placed chest port [1]. Peripherally inserted central catheter (PICC) is widely used as an alternative to the conventional central venous catheter (CVC) for providing intermediate to long term venous access, especially for long term administration of antibiotics, parenteral nutrition and chemotherapy [2]. However, PICC has been related to several complications such as phlebitis, thrombosis, premature dislodgement, malfunction and central line-associated blood stream infection (CLABSI), which may increase the cost in patient management [3, 4].

Tunnelling of the central catheter has been proven to improve the stability and lower the infection rate. The tunnelling of the catheter in the subcutaneous tissue during the catheter placement has decreased the catheter colonization in adults [5]. Furthermore, the tunnelling of the catheter would have moved the skin exit site away from the vein entry site, which potentially reduces the extra luminal infection risk. In view of the above, tunnelling of the PICC might have improved the complications related to the conventional PICC.

Hence, a technique to place a tunneled PICC using the standard PICC set was described. In addition, the catheter dwell time as well as infection rate of tunneled PICC and conventional PICC were compared.
Methods and materials

Procedure Details:

Fig. 1 on page 5 shows the standard PICC set containing a single or double lumen 18-gauge silicon catheter (4F). The upper arm of patient is cleaned with antiseptic and draped. The 5-11 MHz linear ultrasound transducer (covered with sterile endoscope cover) is placed transversely over the vein and the 21G micro puncture needle is slowly advanced into the anterior vein wall under direct sonographic guidance. The anterior and posterior walls frequently oppose as pressure is applied and it is not uncommon to traverse both anterior and posterior walls simultaneously. More importantly, it is necessary to change the direction of the tip when the pressure of the needle tip displaces the vein to gain venous access.

A 0.018" guidewire is inserted into the lumen once good flow is obtained (Fig. 2 on page 5). The wire should enter the vein without hindrance or kinking. Fluoroscopy can be used to view the wire and if there is buckling, the wire should not be inserted further. Once the wire is certain to lie freely within the lumen, the wire can be further advanced. Then, the puncture site is infiltrated with local anaesthetic and the micro puncture needle is removed. A small nick is made at the access site along the wire track making sure that the skin is free. The dilator is withdrawn from the "peel away" sheath and then threaded over the wire to dilate catheter tract. The proposed track for tunnelling is between 5-7 cm from the original venous puncture site and the venous puncture site is then infiltrated with local anaesthetic using same puncture needle or a 21G spinal needle (Fig. 3 on page 6 ). The puncture needle is then bent gently with a more acute curve (opposite the direction of the bevel) at the distal of 2 to 3 cm to allow an easier exit of the needle tip at the venous entry site (Fig. 4 on page 7).

Another nick is made at the distal tunnelled track near the needle entry point and the needle is directed to exit at the original venous puncture site (Fig. 5 on page 8). If the access site is made capacious using blunt dissection, the tunnelling can be performed with greater ease. This can be performed at the initial stage after removal of the micro puncture needle or after track infiltration. Another technique to improve exit of the micro puncture needle after tracking is to use the blunt end of the scalpel to press the skin down. It is important to ensure that the needle path is within the subcutaneous tissue otherwise the tunnelling of the 'peel away' sheath would be difficult.

The wire is then threaded into the needle (Fig. 6 on page 9) and once the tip of wire has exited the hub, the needle and wire slowly withdrawn until the wire is straight. It is important to ensure that the proximal part of the wire within the venous system does not
recoil out while the entire guidewire is being straightened (Fig. 7 on page 10 and Fig. 8 on page 11). The 'peel away' sheath with the dilator is then re-threaded over the wire and pressure is applied over the venous entry point to ensure there is no buckling (Fig. 9 on page 12). The dilator is then withdrawn while the 'peel away' sheath is left in place. After the removal of the dilator component of the 'peel away' sheath, the PICC is introduced through the sheath and advanced into position (Fig. 10 on page 13). Then, the 'peel away' sheath hub is split (Fig. 11 on page 14) and slowly withdrawn while ensuring the PICC does not get pulled back by holding it down by an assistant (Fig. 12 on page 15). The position of the PICC can be checked using fluoroscopy, if necessary. The initial venous access site, as shown by a black arrow in Fig. 13 on page 16, is closed using a Steri-Strip after ensuring there is no oozing from the site. The PICC is anchored using the Stadlock and another Steri-Strip can be placed at the distal end of the subcutaneous tunnel as shown in Fig. 14 on page 17.
Images for this section:

![Image](image_url)

**Fig. 1:** The standard Bard PICC set and the linear ultrasound probe covered with sterile cover.

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Fig. 2: Micro puncture needle with a guidewire threaded into the vein.

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Fig. 3: The track being infiltrated with local anaesthetic using the same puncture needle or a 21G spinal needle.

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**Fig. 4:** The micro puncture needle with the tip deflected from the bevel.

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Fig. 5: Needle tip exiting the original puncture site.

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**Fig. 6:** The guidewire threaded into the needle as it is slowly withdrawn.

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Fig. 7: The operator has to ensure that the proximal portion of the wire does not recoil out from the vein while the entire guidewire is being straightened.

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**Fig. 8:** The wire after it has been straightened with the portion tunnelled in the subcutaneous tissue.

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Fig. 9: Pressure is being applied at the venous access site to reduce buckling of the peel away sheath as it traverses the initial venous access.

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Fig. 10: Double lumen Groschong catheter inserted through the peel away sheath.

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**Fig. 11:** The peel away sheath hub is split.

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Fig. 12: The peel away sheath is slowly withdrawn while ensuring the PICC does not get pulled back by holding it down by an assistant.

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Fig. 13: The initial venous access site (black arrow) is closed using Steri-strips after ensuring that there is no oozing from the site and the bracket shows the length of the tunnelling. The entire set-up is then covered with OPSITE film.

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Fig. 14: The PICC anchored using the Stadlock and another Steri-strip can be placed at the distal end of the subcutaneous tunnel.

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Results

We prospectively performed conventional PICC and tunnelled PICC on two separate patient groups of 50 patients each between the periods of 19 months. All patients were reviewed until either the occurrence of PICC-related complication necessitated removal, completion of therapy, death or till the end of the study. The CLABSI was confirmed in each case by demonstrating concordance between isolates colonising the PICC at the time of infection and from blood cultures.

The mean catheter dwell time for tunnelled PICC at 47 days (2352 catheter-days for 50 tunnelled PICC) was longer than conventional PICC at 27 days (1355 catheter days for 50 conventional PICC). Tunnelling of the PICC has decreased the infection rate from 34% for conventional PICC to 16% for tunnelled PICC. The CLABSI rate for the patient with tunnelled PICC at 6% was also lower than the CLABSI rate for conventional PICC at 12%. The mean time to infection development for tunnelled PICC at 24 days was found longer than the conventional PICC (19 days). The catheter removal due to infection was 24% in conventional PICC patients but was reduced to 4% in tunnelled PICC.

Our results seem to be contradicted with previous reports, suggesting longer catheter dwell time would have posed a higher risk of infections [6, 7]. While all infections were diagnosed during long term follow-up, there were no procedure-related early infections (within 1 week after the procedure) observed with tunnelled PICC patients. In fact, the tunnelled PICC has a longer mean time to infection development compared to conventional PICC. There was no major procedural complications from the technique as no incidence of vascular injury or excessive bleeding, mechanical complications (such as catheter occlusion, fracture or malposition), ‘pinch-off’ or compression point in the catheter line at the venous entry in tunnelled PICC patients. Furthermore, other major complications such as infection or venous thrombosis were found equivalent in both conventional PICC and tunnelled PICC patients.

Tunnelling a PICC has the potential to reducing infection rate and increasing catheter dwell time, provided all other measures recommended for PICC care are implemented. As the technique of tunnelling PICC becomes more widely applied, the benefits such as pain elimination of routine peripheral intravenous access and lower risk of venous inflammation, venous thrombosis and extravasation of cytotoxic agents during chemotherapy will be available to more patients. This will reduce the need of repeated PICC insertions due to infection. As more and more care is shifted towards outpatient care (continuous infusion chemotherapy) and in-home care (palliative medicine), the tunnelled PICC not only reduce the medical cost but also meet the increased societal demand for outpatient cancer chemotherapy. The tunnelled PICC could potentially reduce the need to perform routine central venous port implantation procedures.
**Possible Advantages of Tunnelled PICC:**

Even though the advantages of tunneled PICC compared to chemoport insertion have yet to be elucidated objectively, the fear of an upper arm puncture might be lesser than a subclavian or internal jugular puncture with the additional need for creating a pocket. Additionally, access to the upper arm generally takes lesser effort than access to the subclavian port. Cosmetically, the tunneled PICC do not leave scars on the neck or chest, which makes dressing choices easier. The tunnelling procedure was very well tolerated by patients and only added approximately 5 minutes to the standard procedure time. Creating a tunnel in the arm is much simpler than in the chest and requires shorter procedure time. The skin of the arm is easily withstands the tunnelling process.

Generally, PICC has several advantages than using central lines. Firstly, due of anatomical reasons, pneumothorax does not occur in PICC. Secondly, unlike central vein access in the subclavian / internal jugular / femoral puncture, the use ultrasound eliminates arterial puncture risk. In the off chance of arterial puncture, bleeding can be easily stopped by hand pressure on the puncture site. Venous thrombosis can be ascertained by both compression and colour flow Doppler.

**Possible Limitations:**

There are two possible limitations of the procedure. Firstly, venous access for tunneled PICC has to be made in mid-forearm to avoid tunnelling across the joint. Falling which this may cause mechanical compression and kinking of the PICC as well as migration of the line. Furthermore, this may also limit the patient’s ability to use the arm freely.

The tunnelling of PICC did not contribute much to the stability of the PICC as it did not prevent dislodgement in the tunneled PICC patients. There is a slightly higher number of other complications that are directly related to catheter care seen in the tunneled PICC patients such as leakage and blockage, however, these have not contributed significantly to catheter removal. Both these can be easily overcome by adequate training in inserting tunneled PICC, design changes to the PICC (e.g. with additional of a cuff) and better tools for creating the tunnel.
Conclusion

We have described our simple technique of tunnelling PICC using standard PICC set without the need of any additional expensive or disposal equipment. We believe any operator with moderate expertise can perform this technique following the procedure described. Further improvements in the PICC with the addition of cuffs would enable the tunnelled PICC to be used for multiple functions, which can contribute to a secure, safe and seamless care from anti-cancer therapy to palliative medicine. We hope this procedure will become more common and eventually be validated in prospective multicentre randomised clinical trials regarding its non-inferiority or superiority to other central venous line procedures e.g. PICC with respect to safety.
References


