Introduction

Drugs administered in peripheral veins of the arms should be iso-osmolar, and pH should be close to blood pH. If the pH or osmolarity of the infusate is beyond the physiological range, then the drug falls into the category of irritants.
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and vesicants. Many other factors like DNA binding also contribute to local tissue injury.

Irritants are drugs that produce local inflammation, pain, tightness or phlebitis either at the site of injection or along the veins. Vesicant infusates cause blistering, tissue sloughing or necrosis upon extravasation from the intended vascular pathway into surrounding tissues. Since many chemotherapy drugs fall into either the category of vesicants or irritants, it is recommended to use peripherally inserted central catheters (PICCs) or central catheters for intravenous chemotherapy to avoid these complications. In developing countries, due to financial constraints, upfront use of peripherally inserted catheters continues to be low, and patients receive chemotherapeutic agents through peripheral lines. After few cycles of chemotherapy through peripheral lines, thrombophlebitis leads to attenuation of the veins. The vascular access in peripheral veins is subsequently challenging after few chemotherapy cycles. Over a period of time, these patients require cuffed tunnelled catheters or port placement due to attenuated peripheral vein access.

The non-cuffed tunnelled PICC can be another alternative, when the classical PICC placement is not feasible. We describe a technique to place non-cuffed tunnelled PICC in those patients where conventional PICC placement is not feasible.

### Materials and methods

This is a retrospective analysis of all cases, in which tunnelled PICC insertion was done in our centre between January 2017 and June 2018. Institutional review board waiver was obtained for this study. All these patients involved in this study were suffering from solid malignancies or blood-related disorders and had received treatment through peripheral lines (Table 1). These patients were primarily referred for conventional PICC, and they found to have inadequate veins in upper limbs. The absence of suitable veins in upper limbs was documented in all cases. The cause for attenuation of upper limb veins was due to previous chemotherapy through peripheral lines or congenitally small veins. These patients required vascular access for chemotherapy as well as other drugs. All the central catheter options— including tunnelled cuffed central catheters, port and non-cuffed tunnelled PICC—were discussed with the patients. After discussing the advantages and disadvantages of each method, 19 patients consented for tunnelled PICC placement. Informed consent was obtained from all the patients (Figure 1).

The primary objective of this study was to report safety and feasibility of the procedure. After the procedure, patients were followed up until removal of the PICC or death. During the follow-up period, catheter-related infections, symptomatic thrombosis, catheter malfunction and catheter fractures were discovered.

Catheter-related bloodstream infection (CRBSI) is considered when there is an isolation of the same pathogen from a quantitative blood culture drawn through the PICC and from a peripheral vein with the single bacterial colony count at least threefold higher in the sample from PICC as compared to that obtained from peripheral vein (or) same organism recovered from percutaneous blood culture and from quantitative (>15 colony-forming units) culture of the catheter tip (or) a shorter time to positive culture (>2 h earlier) in the PICC sample than the peripheral sample.

# Table 1. Malignancies of patients.

<table>
<thead>
<tr>
<th>Cancer type</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Single malignancy</td>
<td>14</td>
</tr>
<tr>
<td>Stomach adenocarcinoma</td>
<td>5</td>
</tr>
<tr>
<td>Pancreatic adenocarcinoma</td>
<td>3</td>
</tr>
<tr>
<td>Sarcoma</td>
<td>2</td>
</tr>
<tr>
<td>Germ cell tumour</td>
<td>2</td>
</tr>
<tr>
<td>Acute lymphoid leukaemia</td>
<td>2</td>
</tr>
<tr>
<td>Dual malignancy</td>
<td>5</td>
</tr>
<tr>
<td>Stomach adenocarcinoma and Hodgkin’s lymphoma</td>
<td>2</td>
</tr>
<tr>
<td>Signet ring carcinoma of stomach with breast cancer</td>
<td>1</td>
</tr>
<tr>
<td>Adenocarcinoma of the stomach with colon cancer</td>
<td>2</td>
</tr>
</tbody>
</table>

# Technique

The procedure was performed under local anaesthesia on a day care basis in the fluoroscopy room. The international normalized ratio lower than 1.5 and the platelet count greater than 50,000/mm³ were considered adequate for the procedure. Full aseptic technique was ensured throughout the procedure. In the supine position and with the neck extended and face turned away from the side chosen for line placement, the right internal jugular vein (IJV) was preferred for tunnelled PICC insertion (Figure 2). After anaesthetising the skin and subcutaneous tissues with 1%
lidocaine, access into IJV was made under ultrasound guidance with the 22G puncture needle. Short micro-wire was passed into the IJV. Tip of the micro-wire was manipulated into inferior vena cava under the fluoroscopic guidance. The peel-away sheath is slid over the micro-wire after the removal of guide wire. The peel-away sheath is slid over the micro-wire. After removing the guide wire, BARD Groshong-valved 4F PICC was introduced inside the peel away, and the sheath was then peeled away. The next step is to tunnel the catheter in a retrograde fashion to the exit site. An exit site on the chest wall was chosen, preferably in the upper medial quadrant. Entire subcutaneous track from neck insertion to exit site was infiltrated with diluted 1% lidocaine. The custom-made tunneller was passed from the chest exit site to the neck insertion site. Then, distal end of the PICC was attached to the tunnel and pulled back to chest exit site. The proximal end of the PICC was adjusted by pulling back the distal end, so that tip of the catheter was at the cavo-atrial junction. Fluoroscopy guidance was used for adjusting the distal tip. Excess length of the catheter was trimmed and fixed after attaching the extension provided in kit.

The inserted catheter can be used for drug administration immediately after the procedure. The first dressing is instructed to be changed 24 h after procedure. Regular flushing and dressing changes are carried out on a weekly basis. Syringe sizes larger than 10 mL are used to flush the catheter in order to prevent damage to the Groshong valve. Push and pause technique is used to create turbulence during flushing the catheters. External catheter length is noted during every dressing change, which is matched with the
In this article is technically categorized under tunnelled, non-cuffed centrally placed PICC thus appears promising for vascular access in paediatric population. Since the upper limb veins are smaller in calibre in paediatric patients, the use of non-cuffed tunnelled PICC appears promising for vascular access in paediatric population. However, due to the absence of fixation cuff, unintentional catheter withdrawal can be an issue in paediatric patients.

Table 2. Patient profiles for non-cuffed tunnelled PICC.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of patients</td>
<td>19</td>
</tr>
<tr>
<td>Total number of catheter days</td>
<td>1966 days</td>
</tr>
<tr>
<td>Longest</td>
<td>392 days</td>
</tr>
<tr>
<td>Shortest</td>
<td>1 day</td>
</tr>
<tr>
<td>Average</td>
<td>103.4 days</td>
</tr>
<tr>
<td>Accidental removal/catheter withdrawal</td>
<td>Four patients</td>
</tr>
<tr>
<td>External catheter fracture</td>
<td>One patient</td>
</tr>
<tr>
<td>Purpose served</td>
<td>15 patients</td>
</tr>
<tr>
<td>Died due to disease during the follow-up</td>
<td>7</td>
</tr>
<tr>
<td>Systemic or exit site infection</td>
<td>0</td>
</tr>
</tbody>
</table>

number provided on the procedure notes to rule out any catheter withdrawal.

Results

Out of 19 patients, 18 patients were male (4–72 years). Patient profile includes both solid tumours and haematological malignancies. Five patients had dual malignancies (Table 1). Technical success was achieved in 100% cases. No CRBSI was noted within 30 days of placement. Overall, during 1966 catheter days, no CRBSI was observed. The purpose of PICC was achieved in 15 patients (78.9%) either in the form of completion of chemotherapy (8/15) or maintained PICC till death (7/15). Partial or complete withdrawal was observed in four patients (20.1%), which required re-positioning with cuffed tunnelled catheter or implantable port. External fracture was noted in one patient, which was successfully corrected using repair kit. No exit site infection, bleeding, catheter occlusion, catheter dysfunction, venous thrombosis, venous stenosis or catheter embolization were noted in our series (Table 2).

Discussion

Vascular access in oncology patients can often be challenging, especially after a few cycles of chemotherapy through peripheral lines, which causes veins to become attenuated. Such patients have limited options for drug administration such as cuffed tunnelled catheter or implantable port placement. The cuffed tunnelled catheter and port have their own issues in terms of maintenance, procedure cost and procedure-related complications. This accounts for the use of alternative catheters, which are cheaper, safer and effective in order to overcome the short comings of central catheters. The tunnelled, non-cuffed centrally placed PICC thus appears as promising in such patients. PICC insertion method used in this article is technically categorized under tunnelled, centrally inserted central catheters (CICCs), since the entry point is the IJV.

The purpose of placing PICC was served in 15 out of 19 patients. These 15 patients either completed treatment or died due to primary disease during follow-up. Out of 15 patients, 7 patients succumbed to primary disease during follow-up with non-cuffed tunnelled PICC working till death (Figure 1). It was worth noting that tunnelled PICCs were also used for parenteral nutrition and for injecting other drugs in treating terminally ill patients.

One patient presented with external fracture of the PICC, which was repaired using the easily available repair kit. Redundant external catheter length was likely the cause of the fracture, and we did not encounter any other catheter fracture after trimming the catheter as short as possible. Partial or complete catheter withdrawal was noted in four patients. These patients were either in the paediatric or geriatric age group, and no sutures were used. Subsequent suturing of PICC helped to overcome this problem.

The significantly smaller calibre of tunnelled PICC (4F) allows them to be inserted with very minimal risk and, at the same time, reduces the risk of thrombosis. Smaller calibre of the PICC also allows the procedure to be performed as a day care procedure with increased patient compliance during and after the procedure. The external length of the catheters can be cut short, which also adds to patient comfort. Since the positioning of distal tip is done using fluoroscopic guidance, post-procedure radiographic confirmation was not required.

Unlike tunnelled cuffed catheters, non-cuffed tunnelled PICC lacks the Dacron cuff. Despite the absence of Dacron cuff, zero infection rate is observed in our series. Tunnelling the PICC possibly increases the dwelling time and reduces the risk of thrombosis. Tunnelling the PICC increases the distance between skin entry site and vascular entry site. Despite data are insufficient, increased distance between vascular entry site and skin entry site possibly plays a role in reducing the infection rate. Vascular entry into larger vessel is possible with tunnelling technique, which reduces the risk of thrombosis.

Our results suggest that distance between the skin exit site and the vascular entry site plays a rather important role in preventing infection.

Unintentional catheter fracture and withdrawal during initial cases lead us to shortening the external length and suture the device. We observed that catheter displacement happened in extreme age group of patients. Shortening the external length increased patient compliance, and suturing helped to overcome withdrawal issues. The catheter is cut in such a way that entire catheter is inside body, and only a small extension attachment is visible on the outside.

Since the upper limb veins are smaller in calibre in paediatric patients, the use of non-cuffed tunnelled PICC appears promising for vascular access in paediatric population. However, due to the absence of fixation cuff, unintentional catheter withdrawal can be an issue in paediatric patients.
population. There is scope for research and development of better fixation devices like cuffed PICC to address the catheter migration issue.

Antegrade insertion of open-ended PICC by tunnelling is described by Pittiruti\textsuperscript{12–14} and Bernasconi et al.\textsuperscript{15} Our article describes the retrograde technique for insertion of valved catheter. Pittiruti\textsuperscript{14} reported that tunnelling of PICC helps in reducing the rate of infection and thrombosis as compared to conventional PICC insertion. Our study also gives a similar impression, since we did not encounter any systemic or exit site infection in our series.

Limitations of our study include small sample size and short-term follow-up. Larger study with long-term follow-up period is required before it can be adapted as a gold standard technique.

**Conclusion**

Centrally placed, non-cuffed tunnelled PICC may be considered when conventional arm PICC placement is not feasible. It is an easy and safe procedure that can be performed under local anaesthesia.

**Author contributions**

D.L. carried out all the procedures for the study. A.G., S.S. and S.M. contributed to the preparation and corrections of the manuscript. P.G. contributed to the image and proof reading.

**Consent**

Written informed consent has been obtained from the patients included in the study.

**Declaration of conflicting interests**

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**Statement of human and animal rights**

All the procedures performed in studies involving human participants were in accordance with the ethical standard of institutions and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

**ORCID iD**

Dayananda Lingegowda [ID] https://orcid.org/0000-0002-4899-9170

**References**