The purpose of this study is to evaluate peripherally inserted central catheter (PICC) as a sole venous access device for management of patients with newly diagnosed leukemia.

Forty-four PICCs (4-French, single lumen) were placed in 41 newly diagnosed acute leukemia patients mostly complicated with active systemic infection and bleeding tendency. Sonography-guided venipuncture using a 14-gauge needle sheath was performed because of no grossly visible forearm peripheral veins. PICC insertion sites were basilic vein in 14, brachial vein in 12, cephalic vein in 13, antecubital vein in 4, and in right internal jugular vein in 1 patient after failed antecubital approach. Catheter tips were placed at right atrium and superior vena cava junction in all. The catheters were used for infusion of fluid, chemotherapeutic agents, blood products, and total parenteral nutrition.

No hematoma was encountered. The PICCs were used for a total 3219 catheter-days, with a mean indwelling time of 73.2 days (range 1-247 days). Complications occurred in 18 catheters (18 of 44, 40.9%): puncture site infection in 4, phlebitis in 2, sepsis in 3, catheter clotting in 4, central venous thrombosis in 2, cannulated vein thrombosis in 1, catheter kinking and hub leakage in 1, and accidental removal by nursing personnel in 1. Induction chemotherapy was accomplished in 75% of PICCs (33 of 44), with an average of 1.9 courses (range 1-5 courses).

PICC is safe and useful as an interim central venous access device for management of critically ill, newly diagnosed adult acute leukemia patients complicated with active infection and bleeding tendency.

Key words: Acute leukemia; Peripherally inserted central venous catheter; PICC; venous access

Patients with newly diagnosed acute leukemia traditionally require large bore central venous access for frequent fluid infusion, blood transfusion, blood withdrawal for laboratory tests and parenteral nutrition [1]. To accomplish the above purposes, surgically implanted chest ports or Hickman catheters are often used [1,2]. Unfortunately, chest ports or Hickman catheter insertion in newly diagnosed leukemia patients are associated with high infection rate and access site hematoma formation due to impaired white blood cells function and severe thrombocytopenia [2,3]. A prior study on a general patient population indicates that the small caliber (4-5 French) peripherally inserted central catheter (PICC) is a useful and cost-effective alternative venous access device to conventional central venous catheter [4]. The small caliber peripherally inserted central catheters (PICCs) are theoretically well suited for use in critically ill acute leukemia patients because their insertion through the peripheral vein eliminates the complication of pneumothorax and avoids surgical dissection which are mandatory during Hickman catheter or chest port insertion that may result in access site hematoma formation [5,6,7]. However, little data was collected in the use of small caliber (4-5 French) PICC as a venous access device for management of critically ill acute leukemia patients [4,8,9,10]. The purpose of this study
is to investigate the feasibility of using PICC as an alternative venous access device to Hickman catheter or chest port for management of patients with newly diagnosed acute leukemia.

MATERIALS AND METHODS

From June 1998 to Sep 2000, 41 patients, 20 males and 21 females, aged 42.5-53.3 years (mean 47.6) with newly diagnosed acute leukemia were referred from a team of hematologists for insertion of small caliber PICC due to difficult peripheral venous access. The mean platelet count of these patients before PICC insertion was $4.8 \times 10^4/\mu L$ (range 7000-282000/µL, CI 95%, 3.35-6.27). Each of the 41 consecutive patients received one catheter on initial insertion. Thirty-eight patients had one catheter, and three received two after their initial catheters were clotted or because of insertion sites complications occurred. The PICCs were used for infusion of chemotherapeutic agents, fluid infusion, blood transfusion, blood withdrawal for laboratory tests, and parenteral nutrition during induction of acute leukemia and maintenance of disease during remission.

The catheters were inserted using a standard sonography-guided technique because there were no visible peripheral veins in the forearm regions of these patients. A tourniquet was tied around the arm during sonographic scanning of left forearm veins at 1-2 cm below the antecubital fossa using a 7.5 MHz high-resolution sonographic probe (Acuson, Mountain View, CA, USA). A left antecubital vein (either the brachial vein, basilic vein or cephalic vein) was selected for venipuncture. Left forearm insertion was routinely selected for fear of inconvenience of right arm movement because all our patients are right handed. A 20 cm² wide area around the planned insertion site was cleansed by povidone iodine solution and draped. After local anesthesia, venipuncture was performed using a 14-gauge needle sheath under direct sonographic guidance [9]. A 4-French single lumen Groshong tip PICC (Bard Access System, Salt Lake City, Utah) was inserted into the vein via a plastic sheath after removing the needle stylet. The PICCs were inserted blindly up to the 50-cm mark indicated on the catheter. The final position of catheter tips was checked using fluoroscopy (Fig. 1,2). The introducer sheath was then removed. The external portion of

Figure 1. A PICC enters the basilic vein at left antecubital fossa below the elbow (arrow). Its tip (arrowhead) is positioned at the superior vena cava level. Figure 2. Chest radiograph confirms the location of the PICC tip (arrowhead) at the junction of the right atrium and superior vena cava.
PICC was trimmed to appropriate length and connected to catheter hub (Fig. 3). Only the 4-French single lumen PICC with a hemostatic Groshong slit valve (Fig. 4) (Bard, Access System, Salt Lake City, Utah, USA) was used in this study. After successful insertion, the PICC function was tested by smooth blood withdrawal and saline infusion. The catheter entry site was covered by sterile gauze and then affixed to patient’s skin using a 10 × 12-cm Tegaderm® (3M Health care, St. Paul, MN, USA). No prophylactic antibiotic was given before or after the procedure and no antibiotic ointment was applied to the antecubital venous puncture sites. The gauze covering the catheter entry site was changed daily by nursing personnel.

In this retrospectively study, the medical charts were reviewed. The blood counts before the procedure, date of catheter insertion, insertion site, date of removal, reasons for catheter removal, chemotherapy received, and complications were reviewed. The catheters were followed until they were removed or when patients expired.

**Definition**

A “success” at initial placement of PICC was defined as proper insertion of a PICC with its tip placed at junction of right atrium and superior vena cava. Sepsis is defined as bacteremia of unknown source or developed soon after PICC insertion with positive blood cultures. Cellulitis over the insertion-site of PICC was considered a “local infection” if there is no sign of systemic infection. A venous thrombosis is diagnosed when a thrombosed and distended vein is palpable but not tender. Phlebitis is defined as

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**Table 1. Subtypes of patients with acute leukemia**

<table>
<thead>
<tr>
<th>Subtype</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>AML* M1 M2 M3 M4 M5 M6 M7</td>
<td>35</td>
</tr>
<tr>
<td>ALL** L1 L2 L3</td>
<td>5</td>
</tr>
<tr>
<td>Mixed AML and T cell-ALL</td>
<td>1</td>
</tr>
</tbody>
</table>

* AML: acute myeloid leukemia
** ALL: acute lymphoblastic leukemia

<table>
<thead>
<tr>
<th>Classification</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sepsis</td>
<td>2 (4.5%)</td>
</tr>
<tr>
<td>Suspicious sepsis</td>
<td>1 (2.3%)</td>
</tr>
<tr>
<td>Puncture site infection</td>
<td>4 (9.1%)</td>
</tr>
<tr>
<td>Central venous thrombosis</td>
<td>2 (4.5%)</td>
</tr>
<tr>
<td>Cannulated vein thrombosis</td>
<td>1 (2.3%)</td>
</tr>
<tr>
<td>Phlebitis</td>
<td>2 (4.5%)</td>
</tr>
<tr>
<td>Catheter occlusion</td>
<td>4 (9.1%)</td>
</tr>
<tr>
<td>Catheter leakage and kinking</td>
<td>1 (2.3%)</td>
</tr>
<tr>
<td>Accidental removal</td>
<td>1 (2.3%)</td>
</tr>
</tbody>
</table>

Total 18 (40.9%)
painful sensation and erythema along the inserted vein. Blood clots within the catheter or twisting of the PICC catheter is defined as catheter occlusion.

RESULTS

Forty-three PICCs were inserted in 41 leukemia patients with a 97.7% (43 of 44) technical success rate (Table 1) and one catheter was inserted via right internal jugular vein after a failed antecubital fossa insertion. The insertion sites were basilic vein in 14, brachial vein in 12, cephalic vein in 13, antecubital vein in 4, and right internal jugular vein in one. The mean catheter indwelling time was 73.2 days (range 1-247) and for a total 3219 catheter days. Thirty-three PICCs (75%) have been used for induction chemotherapy for an average of 1.9 courses (range 1-5 courses).

No hematoma was noted at puncture site, and minor oozing was controlled by local compression or stopped after subsequent transfusion of blood products. No prolonged bleeding was noted. Complications directly related to PICC insertion occur in 18 catheters (18 of 44, 40.9%), translating into 5.59 per 1000 catheter days. The average duration from PICC insertion to development of complication was 58.8 days (range 3-225). There were 7 infectious complications (7 of 45, 15.6%) (Table 2). Four local infections (4 of 44, 9.1%) occurred and the mean duration of onset was 14.8 days (range 4-36). Three systemic infections (6.8%) were noted and the mean duration of onset was 103.3 days (range: 52-183). In the patients with systemic infection, one was confirmed by catheter tip culture which grew Staphylococcus aureus. Another patient with suspected systemic infection was unable to be confirmed by blood culture. The other patient with systemic infection had concomitant infection of catheter insertion site, and his wound is routinely compressed for a longer time. The late phlebitis occurs on an average of 18.27 days after insertion. Only 2 late phlebitis occur in our series resulting in an incidence rate of 4.5% and no early phlebitis is noted in our study.

DISCUSSION

Lately, there is a renewed interest in PICC because it is five-times less costly than conventional central venous catheter (CVC) [5]. Smith et al [5] in their review on 838 venous catheters (283 CVC, 555 PICC), observed no increase in infectious complications in PICC as comparison with in conventional central venous catheter. Alhimyary et al [11] in their study on parenteral nutrition via 135 PICC lines for 126 patients shows no significant difference in complication rate in comparison to central venous catheters. In a high risk group patients with acute leukemia, our PICC infection rate is 2.17 per 1000 catheter days in contrast to 2.14 per 1000 catheter days in a general medical group and 2.25 per 1000 catheter days for the HIV group obtain by Ng et al [4]. Bakker et al [7] report a higher infection rate at 4.78 per 1000 catheter days for Hickman catheter in patients with hematologic disorder.

In acute leukemia patient, easy bleeding and high infection rate are the main concerns. Ng et al [4] report that coagulopathy is not a contraindication for PICC insertion even 14.6% of their patients require venous cut down to enable catheter insertion. In their opinion, a pre-procedural coagulation study may not be required in leukemia patients because blood tests and blood transfusions are frequently performed in acute leukemia patients. In other words, blood products may be transfused after PICC insertion if the wound oozing is difficult to stop by manual compression. However, we try to minimize the risk of bleeding by pre-procedural transfusion of fresh frozen plasma when platelet count is below 20000/µL while the wound is routinely compressed for a longer time. Loughran et al [6] obtain a phlebitis rate of 9.7%. In their study, the early phlebitis occurs on an average of 3.7 days after insertion. The late phlebitis occurs on an average of 18.27 days after insertion. Only 2 late phlebitis occur in our series resulting in an incidence rate of 4.5% and no early phlebitis is noted in our study.
study. It is reported that an experienced operator is important in minimizing the incidence of complications and to shorten operation time [4]. A gentle and smooth insertion of PICC may reduce the incidence of mechanical phlebitis which is thought to be related to excessive movement of catheter during insertion [5] and manipulation or movement at excision site [12]. In addition, a proper patient education on daily PICC care should be important. In our hospital, the radiologist plays a key role in the insertion of PICC. Since the nurses are not well-trained in the PICC daily care, the occlusion rate of PICC is still high. We think the phlebitis and occlusion rate of PICC will decrease in the future.

A similar study of PICC in acute myeloid leukemia patients was proposed by Strahilevitz et al [10]. The result of this study revealed a higher phlebitis rate (12 of 40, 30%) and sepsis rate (17 of 40, 42.5%) than our result. We think usage of sonography-guided procedure in our study is the key role to diminish the complications, especially in the development of phlebitis.

In 1974, Ryan and colleagues [13] reported invariable occurrence of thrombophlebitis after ante-cubital-vein catheterization, which was thought to be due to small caliber of vein and excessive movement of PICC at insertion sites. Jay et al [14] however, report a 3.7 to 4.5% incidence of venous thrombosis. In our study, the central venous thrombosis rate is 4.4%. In Anthony’s series, a 23.3% of PICC related peripheral venous thrombosis is reported [15]. Our venous thrombosis rate is 6.8%, in which, two occur in central veins and one in the cannulated peripheral vein. However, our venous thrombosis rate may be underestimated because only symptomatic patients are further evaluated with sonography while the asymptomatic venous thromboses may be missed.

In conclusion, small caliber central venous access catheters inserted via peripheral forearm veins are safe and efficacious for intravenous therapy of newly diagnosed acute leukemia patients. Our study shows that small caliber PICC may be used as an initial venous access device for the management of newly diagnosed acute leukemia patients who require frequent blood drawing, blood product transfusion and parenteral nutrition. It has a comparable infectious complication, venous thrombosis and catheter occlusion rates when compared to conventional large bore central venous catheter. However, proper training in PICC insertion technique and maintenance care are mandatory in order to obtain an acceptable complication rate in these critically ill patients.

REFERENCE

週邊植入式中央靜脈導管於成人急性白血病患者

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急性白血病患者需要建立一條適當的靜脈輸液路徑，以往都是開刀植入大管徑（6-8Fr）的Hickman catheter或是Port A catheter為主。我們嘗試著利用4Fr小管徑的週邊植入式中央靜脈導管來達成此目的。

連續41位急性白血病的新患者（20位男性、21位女性，平均年齡為47.9歲）參與研究，他們大多有全身性的感染及出血傾向（平均血小板為48000/uL）。我們由左手肘處植入了44條中央靜脈導管在這些病人身上。由於在肉眼下看不到這些病人的手臂靜脈，導管的植入是在超音波導引下進行，最後導管末端放至上腔靜脈處。這些導管將作為抽血、靜脈輸液、給藥及化學治療。

放置週邊植入式中央靜脈導管的成功率為97.7%，置入導管的手肘部位並無任何的皮下血腫發生。這44條導管放置在41位病人身上共3219天，平均每條導管放置73.2天。有18條導管發生併發症（佔40.9%），這些併發症包括4條導管有穿刺傷口的感染、2條導管引起靜脈炎、3條導管引起敗血症、4條導管發生阻塞、2條導管引起中央靜脈阻塞、發生放置導管的靜脈阻塞有1條導管、1條導管的導管接頭發生滲漏及此導管發生扭轉的現象、1條導管在日常照護時被意外拔除。這44條週邊植入式中央靜脈導管有33條（75%）曾經被作為化學治療的給藥途徑，平均使用1.9次的化療療程。

週邊植入式中央靜脈導管併發症低於他人報告大管徑導管用於急性血癌患者的結果，而與國外利用週邊植入式中央靜脈導管於一般病人的結果相近。所以對於此高危險群的患者不失為Hickman catheter及Port A catheter的另一種選擇。

關鍵詞：急性白血病，週邊植入式中央靜脈導管，介入性步驟，靜脈