Venous thrombosis and infection associated with peripherally inserted central catheter

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INTRODUCTION

Peripherally inserted central catheters (PICC) are an alternative to central venous catheters (CVC's) in patients requiring long-term venous access (1). The introduction and growing demand of these catheters is based on the fact that, although they share the same indications and uses of central venous catheters, they are considered to be safer at the time of insertion. This is due to the fact that they do not have the risk of pneumothorax or puncture of the subclavian artery because the puncture site is in a peripheral vein, usually of an arm and with ultrasound guidance.

The literature describes that the main complications in the use of PICCs are venous thrombosis and infection, although in some studies it is reported that the risk of the latter appears to be similar to CVCs (2). However, the use of PICCs, as well as multi-lumen catheters, in critically ill patients has been discouraged because of an increased risk of infection. They not only seem to increase this risk, but also accelerate the time of developing complications due to infections (1).

Although it has generally been associated with an increased risk of thrombosis with smaller gauge veins, the minimum caliber misadvised for catheter placement remain uncertain.

The purpose of this study is to determine the incidence of thrombosis and infection associated with the use of PICCs in the Zambrano-Hellion and San José Tec Salud Hospitals. The importance of this study lies in the fact that in the last three years the Department of Interventional Radiology has seen a substantial increase in requests for PICC placements. The first PICC included in this study was placed in March 2015, with a total of 37 PICC for 2015, increasing to 143 in 2016 and 56 in the first half of 2017.

AIMS AND OBJECTIVES

1. To determine the incidence of thrombosis and infection associated with peripheral insertion central catheters implanted by the interventional radiology service of Tec Salud hospitals.
2. Determine if there is a relationship between vein caliber and the incidence of thrombosis.
3. Determine which vein is most frequently accessed.
Methods and materials

METHODS AND MATERIALS

This is a descriptive, observational, longitudinal and retrospective study.

Population: All patients in whom a PICC catheter was placed by the Interventional Radiology service in Tec Salud Hospitals in the period from March 2015 to August 2016.

Exclusion criteria: Patients who do not have reference images of the procedure in the PACS system or description of the vessel (name and diameter) in the RIS system.

Elimination criteria: Patients who have been discharged from hospital with implanted catheter and the date of catheter removal is unknown. The variables evaluated were: 1) Infection associated to the catheter demonstrated by positive culture with the agent isolated. 2) Thrombosis of the vein in which the catheter was inserted, demonstrated by Doppler ultrasound. 3) Insertion site (name of the vein). 4) Caliber of the vein (measured in millimeters). 5) Catheter duration measured in days.

Materials

The PICC catheters that used were 5 and 6 Fr, of 2 or 3 lumens, all provided by the hospital's supplier. Portable ultrasound was used to perform the guided puncture of the selected blood vessel; temporary storage of images where made in the RIS-PACS system, which was later available in the interpretation rooms of hospitals.

Method

All the PICC’s were placed by the interventional Radiology service, which is made up of 3 specialists (FPG, MAC, JSS). Catheters 5 or 6 Fr were used. The catheters were placed only in the upper extremities (Table 2).

<table>
<thead>
<tr>
<th>PICC Diameter</th>
<th>Lumen Number</th>
<th>Double</th>
<th>Triple</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 F</td>
<td>11</td>
<td>161</td>
<td>172</td>
<td></td>
</tr>
<tr>
<td>6 F</td>
<td>0</td>
<td>8</td>
<td>8</td>
<td></td>
</tr>
</tbody>
</table>

*Table 2. Technical characteristics of periferally inserted central catheter (PICC).*
The choice of the number of lumens and diameter of the catheter was according to the criteria of each interventional physician. The site of insertion of the catheter was determined by performing a venous ultrasound of the upper extremity in order to identify the most accessible vein, avoiding as much as possible those veins that were previously accessed and discarding those with previous thrombosis.

The insertion method used by all the interventional radiologists was the same: sterile technique guided by ultrasound (Fig. 4 on page 9, Fig. 5 on page 10, Fig. 6 on page 11). Depending on the patient’s status, all these procedures were performed in the either the intensive care unit, the operating room, the hemodynamic room or the emergency room.

During the procedure, images were recorded on the ultrasound with the measurement of the transverse diameter of the vessel with the calipers placed inside the walls of the vessel, as well as the name of the vessel Fig. 7 on page 12. These images were later available for review in the PACS system and where dictation of the report of the procedure in RIS-PACS was made.

During the procedure, the placement of the catheter inside the vein is confirmed with ultrasound of the accessed vein Fig. 8 on page 13 Fig. 9 on page 14 Fig. 10 on page 15. After completion of procedure the placement of the catheter was confirmed in the cavoatrial junction by portable chest x-ray and in some cases by fluoroscopy. The images were saved in the patient's file.

**Catheter Care:** Interventional radiologists used standard sterile technique, including sterile barriers such as dressings impregnated with chlorhexidine gluconate. The maintenance and manipulation of the catheter was carried out only by the Department of Catheter Clinic.

**Data Collection:** The report and/or reference images of the procedure were reviewed in the Radiology Information System and Picture Archiving and Communication System (RIS-PACS) to collect the data on insertion vessel, vein gauge, catheter gauge and lumens; all was recorded and saved on an Excel spreadsheet.

The patient follow-up information was obtained through the files kept by the Department of Catheter Clinic who is under the care of the Epidemiological Surveillance Unit. In the cases where there was a clinical suspicion of infection, information was obtained through...
their daily log; the number of days the catheter was implanted and the result of the culture were recorded.

The catheters that fell under a clinical suspicion of infection were removed, sent to be cultured in the hospital laboratory. If a positive culture resulted and a successful isolation of the agent were obtained, the corresponding information was recorded.

Doppler ultrasound was used to confirm the clinical suspicion of catheter-associated venous thrombosis, fulfilling at least the following criteria: presence of thrombus, lack of compression of the vessel and lack of venous flow on Doppler examination Fig. 11 on page 16, Fig. 12 on page 17, Fig. 13 on page 18 (1).
Table 1

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### Average duration of PICC use (days)

<table>
<thead>
<tr>
<th>Vein</th>
<th>Right</th>
<th>Left</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basilic</td>
<td>9.16</td>
<td>10.67</td>
</tr>
<tr>
<td>Cefalic</td>
<td>16</td>
<td>5</td>
</tr>
<tr>
<td>Humeral</td>
<td>9.57</td>
<td>5.67</td>
</tr>
<tr>
<td><strong>General Average</strong></td>
<td><strong>9.62</strong></td>
<td><strong>9.62</strong></td>
</tr>
</tbody>
</table>

**Table 4. Average duration of PICC use by vein.**

### PICC technical variables

<table>
<thead>
<tr>
<th>PICC Diameter</th>
<th>Lumen Number</th>
<th></th>
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<tr>
<td></td>
<td>Double</td>
<td>Triple</td>
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</tr>
<tr>
<td>5 F</td>
<td>11</td>
<td>161</td>
<td>172</td>
</tr>
<tr>
<td>6 F</td>
<td>0</td>
<td>8</td>
<td>8</td>
</tr>
</tbody>
</table>

**Table 2. Technical characteristics of peripherally inserted central catheter (PICC).**
Table 2

<table>
<thead>
<tr>
<th>PICC vein insertion site</th>
<th>Basilic</th>
<th>Cephalic</th>
<th>Humeral</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variable</td>
<td>No. (%)</td>
<td>No. (%)</td>
<td>No. (%)</td>
</tr>
<tr>
<td>Right</td>
<td>97</td>
<td>3</td>
<td>21</td>
</tr>
<tr>
<td>Left</td>
<td>52</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>Total PICCs</td>
<td>149</td>
<td>4</td>
<td>27</td>
</tr>
<tr>
<td>Vein thrombosis</td>
<td>3 (2.01%)</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Table 1. Site of insertion of peripherally inserted central catheter (PICC).

Fig. 3

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Fig. 4: Gray scale duplex image in longitudinal view of left basilic vein shows the site of puncture and needle entrance.
Fig. 5: Gray scale duplex image in longitudinal view of left basilic vein shows the site of puncture and needle entrance.

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**Fig. 6:** Gray scale duplex image in longitudinal view of left basilic vein shows the site of puncture and needle entrance.

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**Fig. 7:** Gray scale ultrasound image shows the measurement of left basilic vein in a transverse view.

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Fig. 8: Gray scale duplex image in longitudinal view of left basilic vein shows the site of punction and needle entrance.

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**Fig. 9:** Gray scale duplex image in longitudinal view of left basilic vein shows the guide entrance.

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Fig. 10: Gray scale duplex image confirms the catheter position inside the left basilic vein in a longitudinal view.

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**Fig. 11:** A gray scale duplex image of left axilar vein shows an cute thrombus in a longitudinal view.

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Fig. 12: A gray scale duplex in a transverse view image shows no compression of the left axilar vein due an acute thrombus.

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Fig. 13: Color Doppler ultrasonography of left axilar vein shows lack of venous flow.

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Results

RESULTS

The study period was a total of 30 months, from March 2015 to August 2017, during this time, 236 PICCS were placed, of which 180 met the inclusion criteria. These were placed in 115 patients, totaling 1718 catheter days.

On average, catheter placement lasted 9.6 days. The minimum duration was 1 day and the maximum was 74 days (Table 4).

![Table 4. Average duration of PICC use by vein.](image)
The vessel most frequently accessed was the right basilic vein (97 catheters), most likely due to the fact that on average it has a larger caliber (4.03 mm), followed by the left basilic vein (52 catheters).

The vessel that most frequently presented thrombosis was the basilic vein, however it is also the most commonly accessed. (Table 1)

![Table 1. Site of insertion of peripherally inserted central catheter (PICC).](image)

The vessel caliber was on average 3.93 mm (Table 3). The minimum diameter recorded was 1.2 mm and the maximum diameter was of 8.10 mm.
The incidence of thrombosis was 1.7%. This includes 3 of the 180 catheters that were inserted into the basilic vein with gauges ranging from 3.0 to 3.8 mm, with an average of 5 to 9 catheter days. The incidence of infection was 2.7% which includes 5 of the 180 catheters, 4 inserted in the basilic vein and one in the cephalic vein, with gauges ranging from 1.2 to 2.6 mm, with a span of 7 to 29 catheter days. Infections were caused by *K. pneumoniae* (3), *K. oxytoca* (1) and *S. epidermidis* (1). None of the PICCs placed in vessels with a diameter above 3 mm presented thrombosis or infection.

**Table 1**

**References:** Radiology, Instituto Tecnológico y de Estudios Superiores de Monterrey - Monterrey/MX

<table>
<thead>
<tr>
<th></th>
<th>Right</th>
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<tbody>
<tr>
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<td>Left</td>
<td>3.03</td>
</tr>
<tr>
<td>Cefalic</td>
<td>Right</td>
<td>3.68</td>
</tr>
<tr>
<td></td>
<td>Left</td>
<td>3.91</td>
</tr>
<tr>
<td>Humeral</td>
<td>Right</td>
<td>3.68</td>
</tr>
<tr>
<td></td>
<td>Left</td>
<td>3.91</td>
</tr>
<tr>
<td>General Average</td>
<td></td>
<td>3.93</td>
</tr>
</tbody>
</table>

Table 3. Average of vein calibre for insertion site.
Conclusion

CONCLUSION

It is our belief that the importance of our work lies in the fact that, since the introduction of the PICC catheters in our hospitals, the risk versus benefit of its use has not been formally studied in our region. To date, the use of PICC catheters in our hospitals have yielded excellent results, which we have demonstrated in this study showing low rates of infection and thrombosis. This in turn, will lead to attending physicians increasingly request this catheter, which will only further the relevance and importance of this study.

However, our study has an important limitation, the cases of PICC associated thrombosis were recorded only if it was documented by a Doppler Ultrasound; it is possible some patients experienced this event without knowledge.

Our work will continue with the monitoring of the new catheters placed in our hospitals by the Interventional Radiology service. This will allow us to establish a greater volume of patients and better safety margins when selecting vein caliber for PICC insertion. Furthermore, we will be better equipped to establish with greater certainty the relationship between vessel diameter - thrombosis, and the relationship between days catheter - infection.
Personal information

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Dr. Mariana Del Río - Monterrey Institute of Higher Education´s School of Medicine and Health Sciences.
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