Original Article

Revista de Enfermagem do Centro-Oeste Mineiro
2024; 14/5120
www.ufsj.edu.br/recom

RECOM
Revista de Enfermagem
do Centro-Oeste Mineiro

Effectiveness of ultrasound-guided implantation of peripherally insertion central catheter in oncological patients

Efetividade da implantação guiada por ultrassom do cateter central de inserção periférica em pacientes oncológicos

Eficacia de la implantación guiada por ultrasonido de catéter central de inserción periférica en pacientes oncológicos

ABSTRACT

Objective: To evaluate the effectiveness of the ultrasound-guided peripherally inserted central catheter (PICC) insertion technique compared to conventional and fluoroscopy techniques. **Methods:** Retrospective analysis of the occurrence of complications related to the peripherally inserted central catheter in oncohematological patients. Three PICC insertion scenarios were compared, conventional technique, ultrasound technique and fluoroscopy insertion. **Results:** A total of 227 PICCs were analyzed. They presented complications related to the catheter in 24.3% using the conventional technique, 30.4% using the fluoroscopy technique and 21.5% using ultrasound. **Final remarks:** The study shows that the PICC is an increasingly suitable device for patients who need prolonged intravenous therapy. In the three scenarios analyzed, ultrasound proved to be a high technology and presented positive results when analyzing the occurrences of complications and presented a prolonged length of stay in oncohematological patients.
Descriptors: Catheterization peripheral; Hematologic neoplasms; Effectiveness.

RESUMO

Objetivo: Avaliar a efetividade da técnica de inserção do cateter central de inserção periférica (CCIP) guiada por ultrassom comparada às técnicas convencional e por fluoroscopia. **Métodos:** Análise retrospectiva da ocorrência de complicações relacionadas ao CCIP em pacientes onco-hematológicos. Houve comparação de três cenários de inserção do CCIP, técnica convencional, técnica por ultrassom e inserção por fluoroscopia. **Resultados:** Um total de 227 cateteres foram analisados. Apresentaram complicações relacionadas ao cateter em 24,3% pela técnica convencional, 30,4% pela técnica com fluoroscopia e 21,5% com o uso de ultrassom. **Considerações finais:** O estudo mostra que o CCIP é um dispositivo cada vez mais indicado para pacientes que apresentam necessidade de terapia intravenosa com períodos prolongados. Nos três cenários analisados, o ultrassom demonstrou ser uma tecnologia de ponta e apresentou resultados positivos, quando analisadas as ocorrências de complicações, e ainda apresentou um tempo de permanência prolongado nos pacientes onco-hematológicos.
Descritores: Cateterismo periférico; Neoplasias hematológicas; Efetividade.

RESUMEN

Objetivo: Evaluar la efectividad de la técnica de inserción del catéter central de inserción periférica (PICC) guiada por ecografía en comparación con las técnicas convencionales y de fluoroscopia. **Métodos:** Análisis retrospectivo de la ocurrencia de complicaciones relacionadas con el PICC en pacientes oncohematológicos. Se compararon tres escenarios de inserción de PICC, técnica convencional, técnica de ultrasonido e inserción de fluoroscopia. Resultados: Se analizaron un total de 227 PICC. Presentaron complicaciones relacionadas con el catéter en el 24,3% con la técnica convencional, el 30,4% con la técnica de fluoroscopia y el 21,5% con la ecografía. **Consideraciones finales:** El estudio demuestra que el PICC es un dispositivo cada vez más adecuado para pacientes que necesitan terapia intravenosa prolongada. En los tres escenarios analizados, la ecografía demostró ser una tecnología de punta y presentó resultados positivos al analizar la ocurrencia de complicaciones y también presentó una estadía prolongada en pacientes oncohematológicos.
Descriptores: Cateterismo periférico; Neoplasias hematológicas; Efectividad.

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INTRODUCTION

Cancer is the world's principal public health problem and one of the leading causes of death. In most countries, it is the first or second cause of premature death before the age of 70. The impact of cancer incidence and mortality is increasing rapidly worldwide, mainly because of the demographic and epidemiological transitions the world is undergoing[1].

Estimates show that there will be 704,000 new cases of cancer in Brazil in the three years 2023-2025 - 483,000 excluding non-melanoma skin cancer. The latter is expected to be the most frequent (31.3%), followed by breast (10.5%), prostate (10.2%), colon and rectum (6.5%), lung (4.6%) and stomach (3.1%) new cases[1].

Treatment options currently available to cancer patients include various surgical techniques, as well as radiotherapy and antineoplastic chemotherapy. Antineoplastic chemotherapy, i.e. the use of chemical agents, alone or in combination, to treat malignant tumors, has become one of the most important and promising ways of fighting the disease, being a systemic treatment modality that contrasts with surgery and radiotherapy, which are older and have a more localized action[2].

The constant use of the venous network to administer chemotherapy and long treatments gradually contributes to peripheral catheters becoming progressively obsolete in these cases, making room for longer catheters, preferably central ones. As a result, these devices are being used more frequently in oncohematology, enabling the infusion of other fluids such as blood, its products, and parenteral nutrition in addition to chemotherapy[2].

A good example is the Peripherally Inserted Central Catheter (PICC). According to Vizcayachipi, Fioravante, and Sanches (2013)[3], since the 1980s, PICCs have become a safe option with a low rate of complications in intravenous therapy in hospital settings.

This type of catheter is inserted into the cephalic or basilic vein by percutaneous puncture of the upper limb and reaches the superior vena cava. Its main advantages are a lower chance of mechanical complications (thrombosis and hemothorax), it is cheaper than other central catheters, has lower rates of phlebitis, infiltration, and accidental exit, and can be inserted by a trained nurse[2].

This procedure requires nurse qualification by the Federal Nursing Council (Cofen)[4], according to Resolution no. 258/2001; in Brazil, it is a private activity for nurses and doctors who take a training course, which includes theoretical and practical content related to the insertion, maintenance, and removal of the PICC.

"Blind insertion"[1] is a technique often used in health services for catheter insertion and is commonly adopted by specialist nurses when they decide to insert a catheter. When opting for this technique, the nurse does not have other resources, such as navigation, demanding, therefore, confirmation of the location of the catheter before it is used to administer drugs. Endorsing the correct catheter location, on which its use depends, takes place by carrying out an X-ray examination of the patient's chest and evaluation by the radiologist or oncologist in charge, who must confirm the

[1]Blind insertion consists of inserting the catheter into the selected venous access site in a peripheral vein in the upper arm and progressing through the central venous system until the distal tip of the device is in the lower third of the superior vena cava near the cavo-atrial junction.

correct positioning before starting the fluid infusion. [5].

Tomaszewski et al. (2017)[5] explain that the technique used by radiologists for PICC insertion uses fluoroscopy to visually guide the catheter tip and confirm the correct final positioning employing the angiograph image, enabling real-time monitoring of the headway and final location of the catheter tip.

According to Baiocco and Silva (2010) [6], keeping the catheter tip in a central position is extremely important to reduce complication risks arising from the device use. Thus, the two techniques used in this study include confirming the catheter tip location, which can be done by radiographic image or navigation.

In 2017, the local institution of the study acquired the Site Rite 5 Ultrasound System®, which is a portable device with 2D ultrasound imaging characteristics, suitable for vascular access applications, procedure documentation, vessel caliber measurement tools, and electronic connection.

The interventional radiology department conducts several highly complex procedures, such as guided biopsies, tumor drainage, and the implantation of vascular filters. These procedures are necessary for some cancer patients and should not be postponed, especially in emergency cases. Therefore, to avoid delays in interventional radiology performing these procedures, it would be prudent for the institution to direct the implantation of CCIPs to the catheter outpatient clinic, except for patients with difficult vascular accesses, as previously reported.

A prospective cohort study carried out by Walker and Todd (2013)[7] showed that when catheter insertion success rates were compared between radiologists and nurses, the first group achieved 100% success and the second 93.1%, without statistically significant difference (p = 0.24). However, in the group of radiologists, there was a higher rate of infection (14.58% × 4.4%; p = 0.045) and catheter displacement (8.33% × 2.2%; p = 0.092%). These data corroborate Pratt et al. 's (2007)[8] assertion that most of the costs of inserting central venous catheters (CVCs) are caused by occlusion, mispositioning, and, particularly, infection.

Tomaszewski et al. (2017)[5] argue that limiting the use of the interventional radiology service can reduce patient waiting times, which avoids delays in treatment start, and the difficulty and risks of transporting critically ill patients to the sector, besides reducing the exposure of professionals and patients to the ionizing radiation generated by the X-ray machine.

Given the evidence and increased demand for interventional radiology insertions, a real-world analysis of the effectiveness of insertion techniques by conventional method, fluoroscopy, and ultrasound to reduce catheter-related complications was carried out, based on data from the institution in question, considering the type of technology applied in each sector and the related clinical complications.

METHODS

This is an observational, retrospective cohort, single-center study based on primary data from a High Complexity Oncology Care Center (Cacon), a world reference - belonging to the Ministry of Health and the science and technology career, which guides cancer policy in Brazil, caring for adult and pediatric oncohematological patients from all over Rio de Janeiro state.

The base case consisted of three PICC insertion techniques: the reference one, with the USG technique, and two alternative ones, using conventional and fluoroscopic techniques. In the evaluation design, the study's problem begins with the possibility of avoiding complications related to PICC.

In the base case, we consider that the USG device used in the reference scenario is a BD model Site Rite 5 Ultrasound System®, which requires the BD model Power PICC Catheter®. In the alternative scenarios, the COOK MEDICAL Turbo-Ject® Power Injectable PICC catheter is used by fluoroscopy and the CR BARD Per-Q-Cath® Catheter is by the conventional technique implantation.

The prevalence of complications related to the use of PICC was estimated and grouped into infectious and non-infectious complications. Patients in the non-infectious group were the ones considered to be mispositioned, with catheters not located in the superior vena cava or that migrated to the internal jugular vein, exteriorization, catheter fracture, bleeding, obstruction, and deep vein thrombosis, and in infectious diseases were those of systemic infection, in which there was laboratory confirmation with a diagnosis of PICC-related infection by positive blood culture and the patient's clinical signs, requiring antimicrobial therapy with or without the need to hospitalize the patient. The ones related to local infection were those who only showed signs of phlogosis or tunnelitis, although not presenting positive blood cultures for isolating microorganisms, may also have needed antimicrobial therapy.

The study population consisted of adult oncology patients aged 18 or over on the date of catheter insertion, enrolled at the institution, unit HC1, who underwent PICC insertion between January 1, 2016, and December 31, 2020. The total cohort comprised 448 patients, with 227 (50.6%) selected for convenience and collection of complete information about the procedures relating to catheter insertion, post-insertion follow-up, and removal. Patients who met the age criterion and were enrolled in the pediatrics or pediatric hematology department were excluded.

The data collected on the patients included gender, date of birth, diagnosis, clinic of origin, date of PICC implantation and removal, requesting clinic, insertion site, puncture technique, FRENCH of the PICC, catheter permanence length and removal reason, and whether there were catheter complications leading to its removal, whether hospitalization and treatment were necessary, treatment length in days and obit notifications.

Statistical analysis

Data processing used Excel 2013 and statistical analysis using SPSS software version 2.5, making it possible to draw up a profile of the patients and complication prevalences in the three scenarios and determine the measures of central tendency and dispersion for the variables: patient age and time length the catheter was in place. Descriptive statistics were used for sample distribution regarding age, gender, complications, diagnosis, reason for the PICC removal, permanence length, and insertion site.

Concerning the magnitude effect of the analyzed interventions, the Odds Ratio (OR) of complication occurrences was estimated, comparing the conventional tech-

nique (blind puncture) with USG-guided puncture; the conventional one with fluoroscopy-guided puncture; and USG-guided puncture with fluoroscopy-guided puncture. Poisson logistic regression obtained the p-value to compare techniques and assess complications.

Ethical issues

The confidentiality of the data collected, and the non-disclosure of identities were guaranteed during the study, following CNS Resolution no. 466/2012, with the individuals included being identified by codes and the results grouped and published without identification. Thus, neither did the researchers interfere in the care offered to the patients in the study, nor were any additional invasive procedures carried out by the research - in addition, no individual biological material was stored.

Data collection began after authorization from both the Research Ethics Committees of the Federal University of the State of Rio de Janeiro (Unirio) and the José Alencar Gomes da Silva National Cancer Institute (Inca), CAAE no. 75469517.0.3001.5274, with a minimum risk as the data is collected from the patient's medical records. Given the above, a waiver of the Informed Consent Form (ICF) was requested.

RESULTS AND DISCUSSION

Characterization of patients in the sample

Data was analyzed for all 227 adult oncohematological patients of both genders, over 18 years of age and no upper age limit, enrolled at the institution from the outpatient clinic or the inpatient department who underwent PICC insertion from 2016 through 2020.

In the sample distribution by gender, there was no significant difference between the number of female patients 110 (48.46%), and 117 male patients (51.54%), proving the sample equity.

There was also no significant discrepancy between the age distribution and the type of insertion technique when the population sample was grouped into six 10-year intervals, starting at age 18. However, it was possible to verify that most patients treated in the three scenarios were over 60 years old (30.4%), as shown in Table 1.

Table 1 –Patient profile distribution by age group and PICC insertion technique - Rio de Janeiro, RJ, Brazil (2016 to 2020)

	Conventional CVC		Fluoroscopy CVC		Ultrasound CVC		Overall Total	
Faixa Etária	Number of patients	% of patients	Number of patients	% of patients	Number of patients	% of patients	Number of patients	% of patients
1. 18 to 29 years	5	13.0%	6	13.5%	10	6.9%	21	9.3%
2. 30 to 39 years	1	17.4%	8	2.7%	16	11.1%	25	11.0%
3. 40 to 49 years	7	10.9%	5	18.9%	23	16.0%	35	15.4%
4. 50 to 59 years	5	19.6%	9	13.5%	31	21.5%	45	19.8%
5. 60 to 69 years	13	17.4%	8	35.1%	48	33.3%	69	30.4%
6. 70 or over	6	21.7%	10	16.2%	16	11.1%	32	14.1%
Overall Total	**37**	**100.0%**	**46**	**100.0%**	**144**	**100.0%**	**227**	**100.0%**

Source: Prepared by the authors, 2023.

The decision to stratify the age group over a 10-year interval was performed to see if the age groups representing the youngest population, most frequently affected by diagnoses of hematological lineage disease, would be concentrated in any of the scenarios presented in the study. As can be seen, individuals between the ages of 18 and 29 represented the lowest percentage of distribution among the three techniques[1].

The distribution of patients by clinic of origin and age group is concentrated in the abdominal clinic (58.1%), with a predominant age of 60 to 69 years (22.5%), followed by the hematology clinic (22%), with a predominant age between 18 and 29 years (5.7%).

The impact of cancer in the world in 2020, based on estimates by the Global Cancer Observatory (Globocan), indicates that the disease will have 19.3 million new cases worldwide (18.1 million if non-melanoma skin cancer cases are excluded)[1].

Worldwide estimates show that the ten main types of cancer, including female breast cancer, lung cancer, colon and rectum cancer, prostate cancer and non-melanoma skin cancer, account for more than 60% of all new cases. Regarding Brazil, the estimate for the three-year period from 2023 to 2025 shows that there will be 704,000 new cases, 483,000 if non-melanoma skin cancer is excluded [1].

It was observed that there was a predominance of PICC implementation indications by the abdominal clinic (ABD), responsible for the care of patients with gastrointestinal oncological diseases, in both sexes, female and male, totaling 132 cases (58.1%), including colon and rectal cancer cases and all those related to the gastrointestinal tract. The worldwide estimate for 2020 is that there will be more than 1.9 million new cases of colon and rectal cancer (10.0%), making it the third most common tumor among all cancers [1].

When we look at the diagnosis type distribution, the predominance of gastrointestinal diseases (51.1%) in the indication for PICC implantation becomes more evident, regardless of the technique applied, followed again by non-leukemic hematological diseases (48.9%), as shown in Table 2.

Table 2 – Distribution of patients implanted with PICC by medical diagnosis - Rio de Janeiro, RJ, Brazil (2016 to 2020)

Diagnosis	n (%)
Anal canal CA	33 (14.5)
Colon CA	31 (13.7)
Stomach CA	30 (13.2)
Rectum CA	22 (9.7)
HL	19 (8.4)
NHL	18 (7.9)
Prostate CA	8 (3.5)
AML	8 (3.5)
Esophagus CA	8 (3.5)
Pancreas CA	7 (3.1)
CML	6 (2.6)
Multiple MYELOMA	5 (2.2)

ALL	5 (2.2)
MSD	4 (1.8)
Lung CA	3 (1.3)
Laryngeal CA	1 (0.4)
Other	19 (8.4)
Overall Total	**227 (100)**

Captions: CA - Cancer; HL - Hodgkin's lymphoma; NHL - Non-Hodgkin's Lymphoma; AML - Acute Myeloid Leukemia; CML - Chronic Myeloid Leukemia; ALL - Acute Lymphoid Leukemia; MSD - Myelodysplastic Syndrome.
Source: Prepared by the authors, 2023.

Among men, there were around 1.1 million new cases, with an estimated risk of 23.40 cases per 100,000 men; among women, there were 865,000 new cases, making it the second most common tumor, with an incidence rate of 16.20 cases per 100,000 women[1].

It is noteworthy that the clinic of origin refers the patient to the oncology or hematology clinic, since the treatment indication includes protocols with antineoplastic chemotherapy infusion. This means that the indications for treatment of solid tumors, when they require the infusion of antineoplastics, are carried out by clinical oncology.

Device features

Regarding the venous access site chosen for the PICC implantation, the basilic vein predominated, with no difference between the left basilic vein (33%) and the right one (31.3%), according to Table 3.

Table 3 – Distribution of PICC insertion sites according to the technique used in the three studied scenarios - Rio de Janeiro, RJ, Brazil (2016 to 2020)

Insertion site	Puncture technique			
	Conventional CVC	Fluoroscopy CVC	Ultrasound CVC	Total frequency (n)
	n (%)	n (%)	n (%)	n (%)
Basilic vein L	2 (5.4)	3 (6.5)	70 (48.6)	75 (33)
Basilic vein R	4 (10.8)	21 (45.7)	46 (31.9)	71 (31.3)
Brachial vein R	1 (2.7)	16 (34.8)	7 (4.9)	24 (10.6)
Cubital basilic vein L	13 (35.1)	-	1 (0.7)	14 (6.2)
Cephalic brachial vein L	3 (8.1)	-	9 (6.3)	12 (5.3)
Cephalic brachial vein R	6 (16.2)	-	5 (3.5)	11 (4.8)
Cubital basilic vein R	8 (21.6)	-	3 (2.1)	11 (4.8)
Brachial vein L	-	5 (10.9)	-	5 (2.2)
Cephalic vein L	-	-	2 (1.4)	2 (0.9)
Axillary vein R	-	1 (2.2)	-	1 (0.4)
Cephalic vein R	-	-	1 (0.7)	1 (0.4)
Overall total	**37 (100)**	**46 (100)**	**144 (100)**	**227 (100)**

Captions: R – right; L – left.
Source: Prepared by the authors, 2023.

According to Baiocco (2013)[9], the basilic vein has the largest diameter and highest blood flow of all peripheral veins in the arm, offering, therefore, the most direct route to the superior vena cava, as well as having the fewest valves. Still, according to the author, the flow of the PICC, when inserted into this vessel, is around 95ml/min, only surpassed by central veins such as the subclavian vein (800ml/min).

When the PICC insertion sites are analyzed according to the technique used, the maintenance of the basilic vein is inferred: insertion with fluoroscopy (45.7%; basilic vein R), insertion with ultrasound (48.6%; basilic vein L) and insertion by conventional technique (35.1%; cubital basilic vein L). Conventional insertion is usually carried out in the cubital region because ultrasound is not used, making it hard to puncture outside this area. However, anatomically the PICC will progress into the equivalent basilic vein.

Regarding the French scale for device insertion, the most common were 4 (44.1%) and 5 (41.9%) Fr catheters, observed in all three insertion scenarios. However, the 6-Fr catheters, due to their thickness, were only inserted using fluoroscopy and ultrasound techniques.

The distribution of the time the catheter remained in place showed an average of 99 days. Approximately 45% of patients had the PICC for up to 50 days, and almost 30% of the sample for up to 100 days. One patient had a record of 548 days, and 97 patients had the catheter between 91 and 548 days.

The permanence length was divided into four bands to allow the interpretation of the results. The data shows that there was the same percentage of permanence time in the 30 to 59 days (37.8%) for the three techniques; 90 days and over (37.8%) ranges for the conventional technique; up to 29 days (39.1%) and 90 days and over (37%) for the fluoroscopic insertion technique; and up to 29 days (21.5%) and 90 days and over (45.1%) for the ultrasound insertion technique. If we group all the insertion techniques, there is a predominance of removal times of 90 days or over (42.3%), equivalent to the average shown above.

These data corroborate that the PICC is a medium- to long-term device. In addition, according to Baiocco (2013)[9], it reduces the risk of pneumothorax and the cost of insertion, presents less discomfort reported by patients, and is easy to maintain.

PICC-related complications

When analyzing the causes of PICC removal according to the technique used for insertion, the most frequent reason was related to the end of treatment (51.1%), followed by obit, progression/complication of the disease or Porth implantation, with each of the last three having the same percentage (7.9%), understood that the obit reason was registered when the patient died before the device's removal and when this event was not related to the complications caused by it, according to Table 4.

Table 4 – Distribution of PICC removal reasons by insertion technique - Rio de Janeiro, RJ, Brazil (2016 to 2020)

Reason for PICC loss or removal	CVC conventional	CVC fluoroscopy	CVC ultrasound	Total freq (n)
	n (%)	n (%)	n (%)	n (%)
End of TTM	26 (70.3)	16 (34.8)	74 (51.4)	116 (51.1)

Obit	-	9 (19.6)	9 (6.3)	18 (7.9)
Disease progression/complication	1 (2.7)	4 (8.7)	13 (9)	18 (7.9)
Porth Implantation	1 (2.7)	3 (6.5)	14 (9.7)	18 (7.9)
Local Infection	3 (8.1)	2 (4.3)	11 (7.6)	16 (7)
Systemic Infection	-	8 (17.4)	7 (4.9)	15 (6.6)
Exteriorization	2 (5.4)	2 (4.3)	5 (3.5)	9 (4)
DVT	-	1 (2.2)	2 (1.4)	3 (1.3)
Obstruction	-	-	2 (1.4)	2 (0.9)
Referred to Cemo	-	-	2 (1.4)	2 (0.9)
Bleeding	-	1 (2.2)	1 (0.7)	2 (0.9)
Exteriorization + local infection	2 (5.4)	-	-	2 (0.9)
Poor hygiene conditions	-	-	2 (1.4)	2 (0.9)
Mispositioning	2 (5.4)	-	-	2 (0.9)
PO Complication	-	-	1 (0.7)	1 (0.4)
PICC Fracture	-	-	1 (0.7)	1 (0.4)
Overall total	**37 (100)**	**46 (100)**	**144 (100)**	**227 (100)**

Captions: TTM: treatment; DVT: Deep vein thrombosis; CEMO: PO: PICC:
Source: Prepared by the authors, 2023.

Table 4 shows that among the three techniques, the main reason for the device removal was the end of treatment, corresponding to 70.3% for the conventional technique, 34.8% for the fluoroscopic insertion technique, and 51.1% for the ultrasound one.

In a study evaluating the feasibility and safety of using PICC during autologous transplantation in 60 patients with a follow-up of 1,276 days, the reasons for PICC removal were: end of treatment (70%), fever of unknown origin (15%), catheter-related thrombosis (3.3%), primary bloodstream infection (3.3%), accidental removal (5%), lumen occlusion (1.6%) and death (1.6%)[10].

When the removal reason due to local infection was analyzed, more occurrences in the ultrasound technique (7.6%) were observed. Nevertheless, we must consider the total insertions per technique: 37 conventional insertions, 46 fluoroscopic ones, and 144 ultrasound ones. Furthermore, when bringing up the concept of bedside insertion, which corresponds to the device insertion in a patient under hospitalization conditions, it is carried out using ultrasound technique.

Bedside PICC insertion is less costly and avoids the patient's transportation to angiography compared to implantation using fluoroscopic guidance. The difficulties with PICC bedside include the ideal French scale of the catheter and the optimal location of the tip in the superior vena cava[11].

When we analyze the removal reasons by implantation technique and clinic of origin, we can see that the three most prevalent clinics for implantation requests, abdomen (58.1%), hematology (22%), and oncology (6.2%), maintain "end of treatment" as the main removal reason, regardless of

the technique used, conventional, fluoroscopy or ultrasound.

Although the analysis of the removal reason due to systemic infection presented no cases for the conventional technique, the insertion technique with fluoroscopy and ultrasound presented eight (17.4%) and seven (4.9%) cases in 46 and 144 insertions, respectively.

The distribution of the time length for the catheter remaining in place due to removal by insertion technique was also carried out between the three scenarios analyzed. Four period ranges were established: up to 29 days; from 30 to 59 days; from 60 to 89 days and 90 days or over.

We established groups to classify the complications leading to PICC removal. One group was related to non-infectious complications, such as exteriorization, PICC fracture, mispositioning, poor hygiene conditions, obstruction, bleeding, and deep vein thrombosis (DVT); another was related to local infection cases; another to systemic cases; and one final group received the classification "other reasons" due to removal caused by complications other than the catheter.

Regarding the conventional implantation technique, 50% of the patients had non-infectious complications for up to 29 days. Two out of three (66.7%) patients with local infection remained with the catheter for up to 29 days, with no removal cases due to PICC systemic infection.

When we analyzed insertion using the fluoroscopy technique, we found that among the group of patients with non-infectious complications, the majority (50%) had to have the catheter removed after 90 days. However, when we analyzed infectious complication occurrences, we observed 75% of removals due to systemic infection within 29 days and 100% of local infection (two patients) within 29 days.

Concerning the technique with the use of the ultrasound device, there was an equal removal occurrence from 30 to 59 days, and from 90 days for non-infectious reasons (30.8%), and when analyzing infection occurrences, it was observed that with local infection, 72.7% of the occurrences were in a period of permanence from 90 days, very much related to the device maintenance care; and when we analyze the occurrences of systemic infection the predominant permanence time is from 30 to 59 days (42.9%).

The study estimated the prevalence of complications related to the use of PICC. According to Pernar et al. (2016)[12], two potentially serious complications (bloodstream infection and thrombosis) are possible. Both increase the cost of care significantly and have potentially life-threatening implications.

Comparative analysis of PICC complication prevalence in three study scenarios

The prevalence ratio of complications related to the use of PICC was estimated by comparing the use of an ultrasound device with the blind insertion technique and the fluoroscopic one. The study defined the prevalence of complications as a measure of effectiveness when comparing the three PICC insertion techniques.

The complications were divided into two groups: one related to non-infectious complications, including exteriorization, PICC fracture, mispositioning, poor hygiene conditions, obstruction, bleeding, and deep vein thrombosis (DVT); and the other to infectious complications, which included lo-

cal and systemic infection.

The three scenarios were analyzed by cross-referencing the occurrence data when comparing the two classifications of complications as shown in Table 5.

Table 5 – Comparative analysis of the complication occurrences in the studied scenarios - Rio de Janeiro, RJ, Brazil (2016 to 2020)

Comparison of the three scenarios			Non-infectious complications		Total	Infectious complications		Total
			Without occurrence	With occurrence		Without occurrence	With occurrence	
Scenario 1	**Conventional CVC**	Freq (n)	33	4	37	32	5	37
		% in New puncture technique	89.2%	10.8%	100.0%	86.5%	13.5%	100.0%
	Fluoroscopy CVC	Freq (n)	42	4	46	36	10	46
		% in New puncture technique	91.3%	8.7%	100.0%	78.3%	21.7%	100.0%
Total		Freq (n)	75	8	83	68	15	83
		% in New puncture technique	90.4%	9.6%	100.0%	81.9%	18.1%	100.0%
Scenario 2	**Conventional CVC**	Freq (n)	33	4	37	32	5	37
		% in New puncture technique	89.2%	10.8%	100.0%	86.5%	13.5%	100.0%
	Ultrasound CVC	Freq (n)	131	13	144	86.5%	13.5%	144
		% in New puncture technique	91.0%	9.0%	100.0%	87.5%	12.5%	100.0%
Total		Freq (n)	164	17	181	158	23	181
		% in New puncture technique	90.6%	9.4%	100.0%	87.3%	12.7%	100.0%
Scenario 3	**Fluoroscopy CVC**	Freq (n)	42	4	46	36	10	46
		% in New puncture technique	91.3%	8.7%	100.0%	78.3%	21.7%	100.0%
	Ultrasound CVC	Freq (n)	131	13	144	126	18	144
		% in New puncture technique	91.0%	9.0%	100.0%	87.5%	12.5%	100.0%
Total		**Freq (n)**	**173**	**17**	**190**	**162**	**28**	**190**
		% in New puncture technique	**91.1%**	**8.9%**	**100.0%**	**85.3%**	**14.7%**	**100.0%**

Table 5 – Comparative analysis of the complication occurrences in the studied scenarios - Rio de Janeiro,

Comparative scenario 1: insertion by conventional technique × insertion by fluoroscopy

The total number of patients who underwent conventional and fluoroscopy insertions was 83, with 37 undergoing conventional and 46 fluoroscopy insertions. It allowed us to verify that 10.8% and 8.7% of the patients who underwent conventional insertion and fluoroscopy presented non-infectious complications, respectively.

The analysis in Table 5 shows that by comparison, patients who underwent conventional insertion had a prevalence ratio 1.24 times higher for non-infectious complications than those who underwent fluoroscopy. On the other hand, when the prevalence ratio of complications was calculated for fluoroscopy insertion, the prevalence was 0.8 times lower.

According to the odds ratio data, with a value of 0.79, the conventional insertion technique is more prone to non-infectious complications than the fluoroscopic one, with a 95% confidence interval (CI) ranging from 0.183 to 3.380 and p = 0.948.

An odds ratio of 0.79 means that the occurrence of non-infectious complications in catheter insertion via the fluoroscopic CVC technique is 21% lower than the conventional CVC technique.

In the scenario comparing the occurrence of infection, 13.5% of cases submitted to the conventional technique had an infection, while 21.7% of infection cases occurred in patients submitted to fluoroscopic insertion, totaling 18.1% of cases of infection between the two scenarios.

The prevalence analysis shows that patients who underwent fluoroscopic insertion had a rate of infectious complications 1.61 times higher than those who underwent insertion by conventional technique.

Concerning the prevalence ratio of infections in cases inserted using the conventional technique, the prevalence was 0.62 times lower than in the ones inserted by the fluoroscopy method.

According to the odds ratio, 1.78 of the fluoroscopic insertion technique is more prone to infectious complications than the conventional technique, with a 95% CI ranging from 0.549 to 5.753 and p = 0.174, meaning that the occurrence of infectious complications when inserting a catheter using fluoroscopy is 78% higher than when using the conventional technique.

Comparative scenario 2: insertion by conventional technique × insertion by ultrasound

The total number of patients who underwent insertion using conventional and ultrasound techniques was 181, with 37 undergoing insertions using the conventional technique and 144 using ultrasound. Table 1 shows the occurrence of complications in both scenarios.

The descriptive analysis showed that 9.0% of non-infectious complications occurred in the ultrasound insertion group and 10.8% in the conventional insertion group.

The analysis shows that when compared, patients who underwent conventional insertion had a 1.2 times higher prevalence of non-infectious complications than those who underwent ultrasound insertion.

The ultrasound insertion scenario showed a prevalence ratio of 0.84 com-

pared to the conventional scenario.

Tomaszewski et al. (2017)(5) described limitations to catheter "blind insertion" since mispositioning can increase the risk of complications such as cardiac arrhythmias, venous thrombosis, cardiac tamponade, venous perforation, and catheter malfunction.

According to the odds ratio data, a value of 0.82 indicates that the conventional insertion technique is more prone to non-infectious complications than the ultrasound technique, with a 95% CI ranging from 0.251 to 2.675 and p = 0.756, that odds ratio also means that the occurrence of non-infectious complications with ultrasound catheter insertion is 18% lower than with the conventional technique.

The analysis of the prevalence of infectious complications, shown in Table 1, shows that using ultrasound resulted in an infection prevalence 0.93 times lower than that of patients who underwent the conventional technique. Now, regarding the conventional technique, the infection prevalence was 1.08 times higher than using the ultrasound.

According to the odds ratio, a value of 0.91 shows that the conventional insertion technique is more prone to infectious complications than the ultrasound technique, with a 95% CI ranging from 0.315 to 2.650 and p = 0.878. The value of 0.91 also demonstrates that the chance of infectious complications using ultrasound catheter insertion is 9% lower than the conventional technique.

Comparative scenario 3: fluoroscopic insertion × ultrasound insertion

The total number of patients using ultrasound insertions and fluoroscopy was 190, of which 46 underwent insertion using fluoroscopy and 144 the ultrasound.

In the analysis of non-infectious complication occurrences (Table 1), there were 8.7% in the fluoroscopic insertion group and 9.0% in the ultrasound insertion group.

Table 1 shows that the comparative analysis of patients who underwent insertion using ultrasound had a 1.04 times higher prevalence of non-infectious complications than those who underwent insertion using fluoroscopy, leaving this scenario with a prevalence ratio of 0.96.

Despite this, according to Dale, Higgins, and Rees (2015)[13], major cost savings can be achieved using bedside USG instead of fluoroscopy. This fact is partly attributable to the high cost of fluoroscopy, and much of the cost reduction goes towards bedside implantation - it would be equally equivalent if it were by the blind insertion technique.

According to the odds ratio data, a value of 1.04 indicates that the ultrasound insertion technique is more prone to non-infectious complications than the fluoroscopy technique, within a CI of 95% ranging from 0.322 to 3.368 and p = 0.758, besides, that values of 1.04 also indicate that the occurrence of non-infectious complications caused by the ultrasound technique is 4% higher than the fluoroscopy.

Data from Table 1 displays 10 infection cases by fluoroscopy (21.7%) and 18 infection cases using ultrasound (12.5%), summing up 14.7% of the cases in both scenarios.

Concerning the analysis of the infection occurrences comparing the fluoroscopic and ultrasonic insertion sce-

narios, the prevalence ratio was between 0.58 and 1.74, the former being related to the ultrasonic technique and the latter to cases of infection when using the fluoroscopic technique.

According to the odds ratio data, equivalent to 0.51, the fluoroscopic insertion technique is more prone to the occurrence of infectious complications when compared to the ultrasound technique, with a 95% CI ranging from 0.218 to 1.212 and p = 0.375, besides, an odds ratio of 0.51 indicates that the chance of infectious complications occurring with ultrasound catheter insertion is 49% lower than using the fluoroscopy technique.

According to Dale, Higgins and Rees (2015)[13], there exists a major cost savings when using bedside USG compared to fluoroscopy. This fact is partly attributable to the high cost of fluoroscopy, and much of the cost reduction goes towards bedside implantation - and would be equally equivalent if it were by blind insertion technique.

The use of PICC has increased dramatically since its market introduction in 1980. Currently, the PICC has overcame the use of other central venous catheters (CVC) as the preferred route for the administration of hypertonic sclerosing or irritating intravenous solutions to small caliber veins, for example, total parenteral nutrition, chemotherapy, antibiotics, and inotropic medications[12].

According to the National Cancer Institute (2009)[14], in the oncology field, this device is indicated for obtaining safe central venous access, with immediate implementation of intravenous therapy and often meeting the institutional need to implement a long infusive antineoplastic protocol for gastrointestinal tumors, including at home, which avoids hospitalization of the patient for this procedure.

Bellesi et al. (2012)[10] argue that the use of PICC has considerably improved the management of oncohematological patients by facilitating the infusion of chemotherapeutic agents, antibiotics, and other infusions. The feasibility of using non-tunneled catheters in stem cell transplant patients is possible because these devices have excellent biocompatibility, low cost, bedside management, the possibility of rapid, high-density infusions and a low rate of catheter-related infection.

Initially, PICCs were implanted by interventional radiologists, but recently there has been a movement to have these venous lines implanted at bedside by professionals trained in vascular access procedures. This has been done to increase service availability, contain costs and reduce the workload of interventional radiology[15].

In the same study, which also presented the main reasons for catheter removal, it was observed that 70% were due to the end of treatment, which represents positive data when indicating the device for this clientele.

Bellesi et al. (2012)[10] state that in recent decades, the use of ultrasound to guide catheter implantation has reduced the risk of mechanical complications. Furthermore, the cumulative incidence of DVT in patients with malignant hematological disease after PICC implantation (with fluoroscopy) is 7.8%, and when ultrasound was implemented, the incidence was reduced to 2-4%.

FINAL REMARKS

The study shows that the PICC is a device that is increasingly indicated for patients who require prolonged intravenous therapy, regardless of the original disease. The conclusion is that oncohematological patients, the study's subjects, are included in this profile of individuals with an indication for using the catheter, as it has adequate durability when considering the chemical characteristics of the prescribed compounds, such as fluids with high osmolarity, cytotoxic agents, and large-volume infusions, among others, and because it is a less invasive technology compared to tunneled catheters.

The PICC technology has been shown to be safe and moderately expensive, with a low occurrence of mechanical and infectious complications, especially in onomatology, where the patients are all considered highly complex and often have specific clinical conditions, unlike other groups, such as immunosuppression.

Regarding the presented and compared implantation techniques, and according to the data, the ultrasound technique is a cutting-edge technology that allows implantation at the bedside by qualified professionals (preferably team IV), shows positive results concerning complication occurrences both mechanical and infectious, and demonstrates a prolonged permanence period. The fluoroscopic insertion technique, despite its safety in terms of being able to monitor the real-time progress of the catheter and confirm the location of the tip, still requires a more expensive structure, both in terms of the structure - a radiology room with all the equipment needed to operate the angiography, and in terms of personnel - at least two radiologists and their assistants, usually a direct assistant and a room attendant. In addition, more complex procedures are conducted in the angiography room, such as biopsies, arterial catheterizations, drainage, and intraocular chemotherapy, among others, which would not need to compete with the availability of the team and the area. In this case, it would be more prudent to indicate this technique in cases where ultrasound implantation is unfeasible.

Despite being the least expensive, the conventional technique was more unfavorable than the ultrasound and fluoroscopy insertion techniques since it presents more occurrences of mechanical complications, requiring confirmation of the location of the catheter tip by X-ray examination. Regarding infections, the conventional method was less likely to cause complications than the fluoroscopic insertion technique, even though this characteristic was inverted in the ultrasound.

The lack of standardized medical records hindered data collection, probably excluding records due to incomplete information. This was one of the most important limitations of this study.

The results presented can already be used to support the implementation of new protocols or the incorporation of new technologies related to catheter insertion. They also highlight the need for each institution to assess the number of qualified professionals available to make up the infusion team.

Management needs to assess the service capacity of its institution and its technological park so that the best alter-

native can be implemented for the care of oncological patients.

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Authors' contribution:
Research concept and design: APRS e RCLS.
Data collection: APRS.
Data analysis and interpretation: APRS e RCLS.
Manuscript writing: APRS, RCLS e MF.
Critical review of the manuscript for intellectual content: AS, DA, CB, HR e RCLS.

Responsible editors:
Patrícia Pinto Braga – Editor-in-chief
Juliano Teixeira Moraes – Scientific editor

Note:
This article is part of a doctoral thesis. There was no funding from a development agency..

Recebido em: 07/27/2023
Aprovado em: 04/30/2024

How to cite this article
Siqueira APR, Siqueira ASE, Marta CB, et al. Efetividade da implantação guiada por ultrassom do cateter central de inserção periférica em pacientes oncológicos. Revista de Enfermagem do Centro-Oeste Mineiro. 2024;14:e5120. [Access_____]; Available in:_____. DOI: http://doi.org/10.19175/recom.v14i0.5120.