Alternative vascular device for high-flow computed tomography angiography: ultrasound-guided long peripheral catheter (4 Fr × 10 cm)

Fredy Watts-Pajaro¹ and Francisco L. Uribe-Buritica²

Abstract
Introduction: Radiological studies that require contrast media are common and useful in the emergency department. Alternatives have been proposed for the administration of contrast agent in patients with difficulty in the insertion of vascular access. Since 2017, our institution has used a 4-Fr × 10-cm-long peripheral catheter (Leadercath; Vygon) for venous insertion. Its ultrasound-guided insertion is carried out by emergency physicians. So far, there are no reports in the literature about the use of this long peripheral catheter for computed tomography angiography.

Objective: To describe the experience with the said device, to point out the complications associated with it, and to evaluate it as an alternative way to gain vascular access for patients with limited venous access.

Methods: An observational, analytical, and retrospective study was conducted. The study included patients who received an ultrasound-guided 4-Fr × 10-cm-long peripheral catheter (Leadercath; Vygon). Transparent, radiopaque, polyethylene, 18-gauge Leadercath from Vygon, sold as peripheral arterial catheter and sometimes used “off-label” as venous catheter with a flow capacity of up to 24 mL/min, was used. The flow capacity for gravity flow is 24 mL/s; with pump-driven flow, we achieved a flow infusion of 5–6 mL/s. Univariate analyses were performed. Normality was determined through the Shapiro–Wilk test.

Results: In total, 172 patients met the inclusion criteria. Of them, 115 (67%) were female and the average age was 59 years. The main indication for performing the computed tomography angiography was the suspicion of pulmonary embolism (38.6%). The most frequent type of computed tomography angiography study was pulmonary tomography (88 patients, 51.5%). The contrast medium infusion rate was 6 mL/s in 51.5% (n = 88) of cases, 4.5 mL/s in 36.3%, and 5 mL/s in 12.3%. One adverse event occurred.

Conclusion: An 18-gauge-long peripheral catheter (4 Fr × 10 cm, Leadercath; Vygon) following specific protocols appears to be safe for conducting high-flow computed tomography studies in patients with limited venous access.

Keywords
Catheters, dialysis access, ultrasonography–Doppler evaluation, intensive care, new devices, techniques and procedures

Date received: 6 March 2020; accepted: 6 June 2020

Introduction
Radiological studies that require contrast media are common and useful in the emergency department. Given the recent developments in diagnostic imaging and the implementation of multi-detector computed tomography (CT) scans, contrast medium must now be infused at high rates (flows must exceed 3 mL/s).¹ Infusion rates between 5 and
8 mL/s have been used and have not been associated with increased extravasation, infiltration, compartment syndrome, necrosis, or limb loss when there is adequate vascular access. Different sizes of catheters have been evaluated, but wide diameters are required to achieve flows greater than 5 mL/s. Short catheters (20 gauge or higher) are required. There are risks associated with contrast media infusion, which include phlebitis, extravasation, and infiltration, among others. Extravasation occurs with an incidence rate of 0.3%–0.9%.

Endothelial damage caused by chemotherapy associated with multiple punctures in oncology, hematology, and cirrhotic patients anatomically limits venous access, which is classified as a difficulty in the insertion of vascular access (DIVA). Different alternatives have been proposed for the administration of the contrast agent in patients with DIVA. Central venous catheters (CVC) are indicated only in those patients who are hospitalized or require the administration of medications for long periods. Sanelli et al. analyzed the feasibility and safety of the use of CVC for the infusion of contrast media for tomography, which seems to be an attractive alternative in patients who are carriers of these catheters; however, the use of CVC in patients who are not previous carriers of CVC may not be feasible because of all the risks involved in the insertion.

Since 2017, our institution has used a 4-Fr × 10-cm-long peripheral catheter (Leadercath; Vygon) for venous insertion. Its ultrasound-guided insertion is carried out by emergency physicians who are adequately trained in vascular access for this purpose. So far, there are no reports in the literature about the use of this long peripheral catheter for CT angiography. The objective of this study is to describe the experience in our institution with the said device, to point out the complications associated with it, and to evaluate it as an alternative way to gain vascular access for patients with limited venous access.

Methods

This is an observational, analytical, descriptive, and retrospective study. Patients older than 17 years who received an ultrasound-guided 4-Fr × 10-cm-long peripheral catheter (Leadercath; Vygon) proximal to the cubital fold of the upper limb from 1 January 2017 to 23 October 2019 were included in this study; there were no exclusion criteria. One hundred seventy-two patients were consecutively included. Data were stored in the institutional database of the Clinical Research Center. The institutional medical ethics committee approved the protocol. No financial support was received for this study.

Transparent, radiopaque, polyethylene, 18-gauge Leadercath (Vygon) catheters (4 Fr × 10 cm) with a flow capacity of up to 24 mL/min were used in this study. Access to the vessel was recorded above the flexure in the middle-third of the arm with a 19-gauge needle and a 30-cm non-traumatic metal guide wire with the standard Seldinger technique. The basilic vein was preferred when the diameter was adequate. The institutional protocol for ultrasound-assisted peripheral catheter insertion was applied to patients after two failed anatomical attempts. All physicians who performed the procedure were trained in ultrasound-guided venous access.

The medical records of the patients who met the inclusion criteria were reviewed and variables of interest were collected. Adverse events, infiltration or extravasation related to the device in the medical records, and pharmacovigilance service were recorded. During the study, the radiology staff monitored the device’s flow and pressure on the contrast media infusion pump.

Subsequently, an exploratory analysis of the data was performed, which included randomly taking 10% of the patients and comparing the data entered against the source documents to determine their reliability.

Univariate analyses were performed. The variables’ normality was determined through the Shapiro–Wilk test. Those variables with a p > 0.05 were considered to be normally distributed and are presented as averages and standard deviations; those that were not normally distributed are presented as medians and interquartile ranges. Categorical variables are presented as proportions.

Results

One hundred seventy-two patients met the inclusion criteria; 115 (67%) were female and the average age was 59 years (range: 42–74 years) (Table 1).

Of the 172 registered patients, one adverse event occurred. An 82-year-old patient with metabolic disease (insulin-dependent diabetes mellitus), hospitalized in the context of dyspnea, underwent a 4-Fr × 10-cm catheter insertion due to venous access limitation of the basilic vein. During the procedure, the absence of contrast medium, injected at 5 mL/seg with a high-pressure alert was observed. The examination was suspended and mild edema was observed in the upper limb. Subsequently, it was evaluated by a vascular access team that found evidence of extravasation of the contrast medium with localized edema in the upper limb. Management was given according to institutional protocol for extravasation with physical means, and there were no other complications (Tables 2–4).

Table 1. General characteristics.

<table>
<thead>
<tr>
<th>General characteristics</th>
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<tbody>
<tr>
<td>Male, n (%)</td>
<td>56 (33)</td>
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<tr>
<td>Female, n (%)</td>
<td>115 (67)</td>
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<tr>
<td>Age</td>
<td>59 (42.5–74.5)</td>
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</tbody>
</table>

*Median (interquartile range).
Discussion

CT angiography studies are important, high-utility diagnostic tools in the emergency department. In many cases, the use of high-pressure contrast media is required for the characterization of specific pathologies, for example, in cases of suspected pulmonary embolism or cerebral ischemia. To achieve a high-quality CT image, the use of contrast media (usually iodine derivatives, such as iopromide) is required. This contrast media must be injected at a rate higher than 3 mL/s; however, given the physics involved in the constant flow of the contrast medium, there is a need for large-gauge venous access (4 Fr) catheters to reduce complications. Traditionally, 4 Fr short peripheral catheters are used and inserted by direct visualization/palpation by the nursing staff. Its use is limited in patients with difficult venous access (oncology, hematology, cirrhotic, and multi-puncture patients).

Since 2017, our institution has used an established protocol for the use of long peripheral catheter (18 gauge (4 Fr × 10 cm)) in tomographic studies of patients with difficult access. These long peripheral catheters, inserted under ultrasound guidance by trained physicians, are an alternative for patients with difficult venous access. The institutional protocol requires several specific recommendations for this type of access:

- It must be done exclusively by physicians trained in ultrasound-guided vascular access.
- The catheterized vein is the basilica above the flexion of the upper limb, in the inner proximal third of the arm.
- The catheter must not occupy more than one-third of the lumen of the vessel. Eighteen gauge = 4 Fr = 1.3 mm; therefore, the minimum diameter of the vein is 3.9 mm.

There is no evidence in the literature of long peripheral catheter use for intravenous contrast, which is striking. This idea was conceived due to our institution’s access to ultrasound and trained physicians. Overall, 172 long peripheral 4 Fr catheters were implanted for venous access, and only one non-severe complication was identified. In our 2 years of experience, we consider the use of long peripheral catheters an attractive and safe option for patients with difficult venous access. For this reason, this vascular approach seems tempting and feasible in institutions where bedside ultrasound is available.

This study, although observational, is the first report about using long peripheral catheters to achieve venous access in patients with difficult anatomical venous access. We recognize the limitations of the study since it is retrospective and observational, which leads to inherent biases in its design. Because this procedure is an ultrasound-guided procedure, it will have limited use in centers where this resource is limited.

Conclusion

The use of 18-gauge long peripheral catheters (4 Fr × 10 cm) following specific protocols appears to be safe for conducting high-flow CT studies in patients with limited venous access. We recognize the need for prospective studies in which such an intervention is evaluated.
Declaration of conflicting interests
The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding
The author(s) received no financial support for the research, authorship, and/or publication of this article.

ORCID iD
Francisco L. Uribe-Buritica https://orcid.org/0000-0003-4929-3660

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