Ultrasound-guided tip location of midline catheters

Stefano Elli1, Mauro Pittiruti2, Valentina Pigozzo1, Luigi Cannizzo1, Luciano Giannini1, Andrea Siligato1, Egle Rondelli1, Giuseppe Foti1 and Alberto Lucchini1

Abstract

Introduction: Midline catheters are widely used in clinical practice. Proper placement of midline catheter tip is usually assessed only by aspirating blood and flushing with normal saline without resistance.

Purpose: To describe the ultrasound-guided tip location for midline catheters and its feasibility and to compare incidence of catheter-related venous thrombosis associated with or without ultrasound tip localization.

Methods: The ultrasound-guided tip location is described step by step. Feasibility of the technique and incidence of catheter-related venous thrombosis were measured (study group) and compared with two historical groups: study group, 20-cm midline catheters inserted with ultrasound-guided tip location; group 1, 25-cm midline catheters inserted without ultrasound-guided tip location and group 2, 20-cm midline catheters inserted without ultrasound-guided tip location.

Results: In the study group, ultrasound-guided tip location was easily feasible in 98.9% of patients. Incidence of catheter-related venous thrombosis was 2.42% in control group 1, 9% in control group 2 and 2.62% in the study group.

Discussion: In the study group and control group 1, the tip was placed in the axillary vein, about 3 cm distal to the clavicle and in the subclavian vein. In control group 2, the tip was probably located at the transition between the axillary and the subclavian vein. It is possible that such position may have been associated with an increased incidence of catheter-related venous thrombosis.

Conclusion: The ideal position of the tip of a midline catheter might be inside the axillary vein, about 3 cm distal to the axillary-subclavian transition or inside the subclavian vein. Ultrasound-guided tip location is safe, inexpensive, easy and potentially useful during midline catheters insertion.

Keywords

Nursing, midline catheter, tip location, ultrasound, catheter-related venous thrombosis

Date received: 29 July 2019; accepted: 18 January 2020

Introduction

Midline catheters (MC) are widely used in clinical practice, though some controversies exist as regards definitions1 and indications.2 Historically, MC was introduced in clinical practice around 1980, before the advent of ultrasound-guided venepuncture: MCs were typically 20–25 cm long, so that – being inserted at the antecubital fossa – their tip was located in the brachial tract of the axillary vein.3 After the worldwide adoption of ultrasound guidance, MCs are now currently inserted by the modified Seldinger technique, following the same rules of peripherally inserted central catheters (PICCs) in the so-called Green Zone of the arm, according to the Zone Insertion Method.4 This implies that the tip is located in the thoracic tract of the axillary vein or in the subclavian vein (so-called ‘midaclavicular’ lines).5

1 General Intensive Care Unit, Emergency Department, University of Milan-Bicocca, ASST Monza, San Gerardo Hospital, Monza, Italy
2 Department of Surgery, Catholic University Hospital, Rome, Italy

Corresponding author:
Stefano Elli, General Intensive Care Unit, Emergency Department, University of Milan-Bicocca, ASST Monza, San Gerardo Hospital, Via Pergolesi 33, Monza 20900, Monza and Brianza, Italy.
Email: s.elli@asst-monza.it
Shorter MCs (6–15 cm long), usually called ‘mini-midlines’ or ‘short midlines’ or ‘long peripheral cannulas’, are also available; though they are quite different from standard MC, they are generally inserted by direct Seldinger technique in deep or superficial veins of the arm or forearm and their tip is consistently inside veins of the arm.

The final location of the MC tip depends on many factors: length of the catheter, length of the arm and level of the puncture site in the arm. The proper placement of the MC tip is usually assessed by aspirating blood and flushing with normal saline without resistance.

Current recommendations suggest planning the exit site of MCs (as much as the exit site of PICCs) adopting Dawson’s ZIM™ Method. Dawson’s yellow zone is not ideal for the exit site of venous catheter, since it is too wet and potentially contaminated by the bacteria of the axilla (rich in hairs); the red zone is not recommended, since it is too close to a flexion area, thus, Dawson’s green zone is usually recommended as ideal for proper management of the exit site. As this green area is approximately 7 cm wide, a puncture in this zone — by using either 20- or 25-cm MC — can be associated with a wide variation in the position of the tip (up to 12 cm). In other words, depending on the choice of the puncture site and on the choice of the catheter, the tip of an MC in the so-called ‘midclavicular’ position may be anywhere in the tract of the venous system including the thoracic tract of the axillary vein and the subclavian vein (Figure 1).

In 2018, our group (the vascular access team of a tertiary University Hospital) started to use ultrasound guidance to verify the location of the tip of MCs. The occasion for such decision was the increased incidence of MC-related venous thrombosis after a shift from 25- to 20-cm long MCs, due to a change in the hospital purchase of MCs. Our hypothesis was that the location of the tip might have a role as determinant of the risk of thrombosis and that a proper ultrasound-guided location of the tip might help in controlling such complication. On an empiric basis, we decided to locate the tip in the thoracic tract of the axillary vein, 3 cm below the clavicle.

**Purpose**

The purpose of this study is, first of all, to describe the intraprocedural ultrasound-guided tip location (USGTL) of MCs, verify its feasibility and to compare incidence of catheter-related venous thrombosis (CRT) associated with different midline length with or without ultrasound tip localization.

**Methods**

**Description of the technique**

Intra-procedural USGTL was adopted during the insertion of 20-cm long MCs. The puncture site (and exit site) was consistent in Dawson’s green zone. Before the procedure, a large sterile surgical field was prepped so as to include the area from mid-arm to the infra-clavicular region.

MCs were inserted according to the modified Seldinger technique; after removal of the peel-away sheet, the USGTL was performed as follows:

1. Placement of the ultrasound probe parallel to and below the clavicle;
2. Visualization of the axillary vein in short axis, below the clavicle;
3. Rotation of the probe so to visualize the axillary vein in long axis, as well as the clavicle;
4. Visualization of the tip of the MC inside the axillary vein;
5. Movement of the MC so as to place its tip within the axillary vein, approximately 3 cm distal to the periosteal shadow of the clavicle (Figure 2);
6. Securement of the MC in such position.

Feasibility of the technique and incidence of CRT were measured in consecutive patients observed over a 9-month period (study group). CRT rate in study group was also compared with two historical control groups. Observed groups were as follows:
• Study group (from July 2018 to April 2019): 20 cm 4Fr and 5Fr MCs (CT Midline®, MedComp) inserted with USGTL;
• Control group 1 (from January 2017 to December 2017): 25 cm, 4Fr polyurethane MCs (Midline LifeCath®, Vygon) inserted without USGTL;
• Control group 2 (from March 2018 to June 2018): 20 cm, 4Fr and 5Fr MCs (CT Midline®, MedComp) inserted without USGTL.

All MCs insertions were performed following the SIP bundle recommendations. In particular, the catheter to vein ratio, both for 4Fr and 5Fr MCs, was consistently lower than 1:3, and sutureless securement was adopted in all groups. All MCs were used for infusion of peripherally compatible drugs.

All episodes of symptomatic CRT were recorded. After suspicion on clinical basis, diagnosis of CRT was confirmed by ultrasound examination (evidence of partially compressible or non-compressible venous lumen, or homogeneous appearance of clots, as evaluated by experienced operators).

For the evaluation of the feasibility of USGTL procedure, we considered the procedure ‘feasible’ when it was possible to clearly visualize the MC tip in the axillary vein. Ethics Committee’s authorization were obtained before extracting and analysing data (Ethics approval no. 1136, code: FAVEPRO, 19 June 2018).

### Statistical analysis

Data from the study were stored and analysed by IBM Corp. Released 2016. IBM SPSS Statistics for Windows, Version 24.0, Armonk, NY: IBM Corp.

One-way repeated measures analysis of variance was used, a p value < 0.05 was considered statistically significant.

### Results

We studied 981 MCs: 412 consecutive MCs in control group 1, 111 consecutive MCs in control group 2 and 458 consecutive MCs in the study group.

In the study group, USGTL was easily feasible in almost all patients (453 patients=98.9%); only in 5 patients, characterized by morbid obesity, the tip of the MC could not be identified with certainty.

All CRT were located at the tip of the MC. The incidence of CRT in control group 1 and in the study group was similar (p = 0.852), while the CRT in control group 2 was significantly higher. In particular, the difference between control group 2 and the study group was highly significant (p = 0.002). In control group 2, we studied MCs positioned in the period with increased incidence of CRT, so its numerosity is lower than the other groups.

The main characteristics of the sample and CRT rate observed are explained in Table 1.

### Discussion

Recent studies reported a CRT rate for MCs ranging from 4% to 11%, even if there is some margin of uncertainty due to the different terminology adopted by the different studies, so that it is not always clear whether the device is a standard midclavicular 20- to 25-cm MC or 8- to 10-cm ‘short’ midline.

The main result of our study was that we found a significant difference of CRT between control group 2 and the study group; though the same type of catheter and the same insertion technique were used, the only difference was the adoption of the USGTL. No other disturbing factors were recorded.

CRT in PICCs is usually related to the patient’s disease, the material of the device and the technique of insertion. It is reasonable to assume that the same factors may play a role in MC-related venous thrombosis.

As all MCs were used exclusively for peripherally compatible infusion, we assume that the episodes of CRT were mostly related to a mechanical trauma to the endothelium and not to a chemical trauma.

Our data suggest that the location of the tip of the midclavicular MC may be particularly important in this regard. In control group 1, using a 25-cm MC inserted in the green zone, the tip of the catheter was probably located in the subclavian vein, proximal to the clavicle. In control group 2,
using a 20-cm MC, the tip was probably located at the transition between the axillary and the subclavian vein, that is, just under the clavicle. In the study group, the tip was specifically placed in the axillary vein.

Considering that the axillary-subclavian transition is characterized by a lower calibre of the vein (compression between the first rib and the clavicle) and by a curve of the trajectory of the vein (the axillary vein and the subclavian vein are not in the same axis), it is possible that such position of the tip may have been associated with an increased incidence of CRT, due to mechanical damage of the endothelium. On the contrary, in control group 1 and in the study group, the tip was located so as to have less risk of trauma to the venous wall. Unfortunately, this is one limitation of this analysis, since no USGTL was adopted in the historical control groups, this hypothesis should be corroborated by further studies.

This is a retrospective observational analysis, and the numerosity of studied sample in group 2 is lower than the other groups. Patients in control group 2 were those with a high rate of CRT. As explained above, USGTL was created, and adopted as soon as possible, to try stopping the increase in CRT frequency after our MCs length change. It is possible that the lower numerosity of control group 2 may affect the validity of the results. Furthermore, larger studies will be needed for a higher statistical significance.

Conclusion
As far as we know, this is the first clinical study reporting the possibility and the potential benefits of locating the position of the tip of midclavicular MCs using ultrasound. During insertion of MCs, USGTL is safe, inexpensive, easy in the vast majority of patients and potentially useful in correlating the location of the tip with the incidence of malfunction and/or of CRT. Our study suggests that the ideal position of the tip of an MC, in terms of reduction of the risk of CRT, might be inside the axillary vein, distal to the axillary-subclavian transition, or inside the subclavian vein, proximal to the transition area. It is not so important if a 20- or 25-cm long MC is used but is important to avoid the axillary-subclavian transition area during tip placement. USGTL should be routinely used for this purpose.

Obviously, more studies are warranted so as to correlate different positions of the tip of the MC to the incidence of non-infective complications (thrombosis, malfunction, occlusion, etc.). At this time, outcomes observed show that a correct tip positioning of MC may help to reduce CRT rate.

In the near future, the routine use of this ultrasound-based method of tip location may prove to be important during insertion of MCs.

Author contributions
S.E., V.P., L.C., L.G., A.S. contributed in the collection of data; S.E. and M.P. wrote the manuscript; E.R., G.F. and A.L. analysed the data.

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 iDs
Stefano Elli i https://orcid.org/0000-0002-8785-824X
Alberto Lucchini i https://orcid.org/0000-0002-7475-277X

References

