

Femoral venous access: State of the art and future perspectives

Maria Giuseppina Annetta¹ , Stefano Elli² , Bruno Marche¹,
Fulvio Pinelli³  and Mauro Pittiruti¹ 

The Journal of Vascular Access
1–11

© The Author(s) 2023

Article reuse guidelines:

sagepub.com/journals-permissions

DOI: 10.1177/11297298231209253

journals.sagepub.com/home/jva



Abstract

In the past 5 years, non-dialysis femoral venous access has changed in terms of indications, techniques of insertion, and expected incidence of complications. To the traditional non-emergency indication for femoral catheters—obstruction of the superior vena cava—many other indications have been added, both in intensive and non-intensive care. The insertion technique has evolved, thanks to ultrasound guided venipuncture, tunneling, and ultrasound based intraprocedural tip location. Insertion of femorally inserted central catheters may be today regarded as a procedure with an extremely low intraprocedural and post-procedural risk. The risk of infection is reduced by the possibility of the exit site at mid-thigh, by the use of cyanoacrylate glue for sealing the exit site, and by appropriate intraprocedural strategies of infection prevention. The risk of catheter-related thrombosis is low, due to several concomitant strategies: a proper match between vein diameter and catheter caliber; an accurate intraprocedural assessment of tip location by ultrasound and/or intracavitary ECG; the consistent use of ultrasound guided venipuncture and micro-introducer kits; an adequate stabilization of the catheter at the exit site. The risk of mechanical complications and the risk of lumen occlusion are minimized when using polyurethane, power injectable catheters. All these novelties have brought a revolution in the field of femoral venous access, so that this route may be considered as safe and effective as other approaches to central venous catheterization.

Keywords

Femoral vein, vascular access devices, ultrasonography, catheter tip position, catheterization, central venous, emergency medicine

Date received: 23 August 2023; accepted: 6 October 2023

Introduction

In the past few years, femoral venous access has rapidly evolved in terms of both insertion techniques and indications. Historically, the femoral vein access was synonym of puncture/cannulation of the common femoral vein at the groin, with the catheter exit site always located at the inguinal groove. Also, there was no particular attention about the final position of the catheter tip, which was located indifferently in a proper “central” location (inside the inferior vena cava) or—most of the times—in more peripheral locations (inside the iliac veins); in fact, considering the limited length of the available catheters, often only 20 centimeters (20 cm), the tip of most femoral catheters could not reach the inferior vena cava. Third, there was no differentiation between emergency versus elective

insertion of femoral catheters in terms of insertion and management strategies. Last, most of the puncture were performed “blind,” without the use of ultrasound guidance. This “old” approach to femoral venous access was inevitably associated with a high incidence of infective

¹Vascular Access Team, Fondazione Policlinico Universitario “A Gemelli,” Roma, Italy

²ASST Monza, San Gerardo Hospital, University of Milano-Bicocca, Monza, Italy

³Azienda Ospedaliero Universitaria Careggi, Florence, Italy

Corresponding author:

Mauro Pittiruti, Department of Surgery, Catholic University Hospital, Largo F. Vito 1, Roma 00168, Italy.
Email: mauropittiruti@me.com

associated with the risk of pleuropulmonary complications, and leaves the airways and the chest available for maneuvers of resuscitation and ventilation. Though, most of the femoral catheters inserted in emergency are only 20–25 cm long; this implies that—in most adult patients—they should be regarded as “peripheral” venous accesses, since the tip is most likely inside the iliac veins. Also, as the exit site is typically at the groin, the risk of infection and thrombosis is high.¹⁶ Nonetheless, this risk becomes clinically acceptable if the catheter—as recommended for all catheters inserted in emergency situations^{8,10}—is appropriately removed early, that is, within 48 h. Emergency femoral catheters should always be inserted by ultrasound guided venipuncture¹⁷; they may have different calibers and they may be single, double, or triple lumen: 4–8 French (Fr) catheters are most used in children and adults, but sometimes 11.5–13 Fr double lumen catheters are chosen, not for the need of dialysis but for the purpose of having a “high flow” device. In the contingency of the emergency, maximal barrier precautions are seldom adopted (hence the need of early removal) and tip location methods are not considered as mandatory. Though, even in the emergency setting, “minimal” strategies of infection prevention (sterile gloves, antisepsis with chlorhexidine, small sterile field) are nonetheless required.

In elective clinical situations, clinicians should adopt a different aptitude. An appropriate structured insertion bundle, such as the SIF protocol (SIF=Safe Insertion of Femoral catheters),^{18–20} is strongly recommended. The SIF protocol includes a preprocedural ultrasound evaluation of the veins before the procedure,²¹ skin antisepsis with 2% chlorhexidine in alcohol, maximal barrier precautions, proper choice of the puncture site and of the exit site,¹⁷ ultrasound guided venipuncture, intraprocedural tip location by ultrasound^{22–24} or by intracavitary ECG, adequate catheter securement, and protection of the exit site. As already mentioned, most of the complications traditionally ascribed to femoral catheters (infection, venous thrombosis, dislodgment) are basically related to the exit site at the groin, which should be avoided as much as possible outside of emergency situations. This means that two possible options are commonly recommended for the elective femoral access not meant to be used for dialysis or apheresis¹⁰: (1) ultrasound guided venipuncture of the superficial femoral vein, with exit site at mid-thigh^{13,25,26}; (2) ultrasound guided venipuncture of the common femoral vein at the groin, tunneling the catheter downwards so to obtain an exit site at mid-thigh.^{16,27,28} On the other hand, for short-term non-tunneled dialysis catheters, the only practical option is the ultrasound guided venipuncture of the common femoral vein at the groin, with the exit site in the inguinal area: as the length of non-cuffed dialysis catheters does not exceed 25 cm, any attempt to achieve an exit site more distally, far from the inguinal groove, will result in an inappropriate position of the tip (not inside the inferior vena cava but in the common iliac vein).²⁹

As recommended in the SIF protocol, all non-dialysis catheters placed outside emergency should be inserted using intraprocedural methods of tip location, so to obtain real time documentation that the tip is appropriately located either in the inferior vena cava or in the right atrium (see below).

For short term non-tunneled dialysis femoral catheters, tip location methods are not currently adopted, since these catheters are relatively short; as mentioned above, maximal effort should be done so to place the tip into the inferior vena cava, which means (a) using 24–25 cm long catheters in adult patients, and (b) accessing the common femoral vein as proximal as possible. If these conditions are not met (e.g. if a 20 cm long dialysis catheter is inserted in an adult patient, accessing the vein distally to the inguinal groove), the tip will not reach the inferior vena cava, and the performance of the catheter in terms of flow will be impaired.

Choice of the vein and of the exit site: New options

FICCs are usually considered as an option when central venous catheterization via a cervico-thoracic approach—so called centrally inserted central catheter (CICC)—or via a brachial approach—peripherally inserted central catheter (PICC)—is not feasible or expected to be difficult, or overtly contraindicated. For example, compression or neoplastic infiltration of the superior vena cava is a typical indication for inserting a FICC, if central venous access is required.

Until a few years ago, the only venous approach for FICC insertion in children and adults was the puncture/cannulation of common femoral vein at the inguinal groove. Unless the catheter had been tunneled, the exit site was at the groin, and this was associated with a high risk of catheter-related infection and catheter-related venous thrombosis.⁶ This explains why most guidelines recommended to use femoral venous access only in the absence of alternative options or in emergency.

In the last decade, the implementation of the tunneling techniques, which has been applied progressively also to non-cuffed catheters,^{19,20,29,30} has allowed to overcome some of these issues: cannulation of the common femoral vein is currently compatible with an exit site far from the groin, tunneling either downwards (to mid-thigh) or upwards (to the abdomen).^{16,27,31}

More recently, the increasing use of ultrasound guidance for preprocedural vein assessment^{21,32,33} and for venipuncture¹⁷ has actualized the possibility of considering other veins of the lower limb—such as the superficial femoral vein, the saphenous vein, or the popliteal vein^{13,25,34–37}—for the purpose of venous catheterization.

In the last few years, ultrasound guided venipuncture of the superficial femoral vein has emerged as an interesting strategy to achieve an exit site at mid-thigh, relatively far

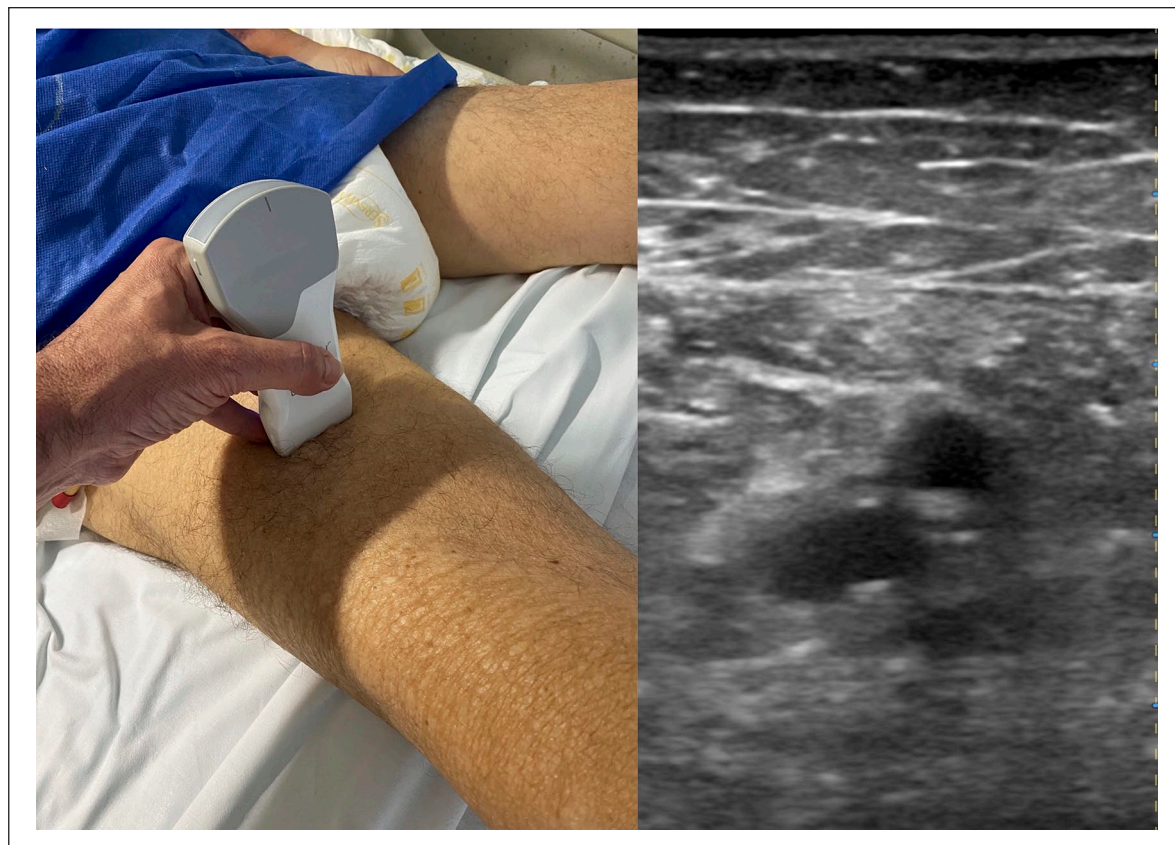


Figure 2. Ultrasound visualization of the superficial femoral vessels at mid-thigh.

from the groin, without the need for tunneling.^{25,37,38} Anatomically, the superficial femoral vein is defined as that portion of femoral vein which begins from the popliteal vein in the adductor canal (Hunter's canal) and ends just below the inguinal groove, merging with the deep femoral vein to form the common femoral vein. The superficial femoral vein is usually located between 3 and 6 cm from the skin surface, below the sartorius muscle, close to the superficial femoral artery and saphenous nerve.²⁵ In adults, its caliber is usually between 4 and 8 mm.²⁵ The venipuncture is performed with a micro-introducer kit (21 G needle, soft, straight nitinol guidewire, 7 cm long micro-introducer). The approach of the venipuncture to the superficial femoral vein can be done either by the short axis out-of-plane technique, or by the oblique axis in-plane technique (Figure 2). One of the main advantages of this approach is the possibility of achieving a long-term venous access even in patients with severe abnormalities of the coagulation or undergoing antithrombotic treatments.³⁹

When adopting the venipuncture of the superficial femoral vein in adults, 20–25 cm catheters will have their tip located in the common femoral vein or in the external iliac vein (and they will be considered “peripheral” venous devices); if a proper “central” venous access is required,

50–60 cm catheters should be chosen, so that their tip may reach the inferior vena cava (and this will be a proper “central” venous catheter, i.e. FICC). In pediatric patients, shorter catheters (30–40 cm) may be used, depending on the age and weight of the child; the actual length required can be established properly only during the maneuver, using an intraprocedural method of tip location.^{19,40}

New options for the tip location in the inferior vena cava

The methods of tip location of femoral catheters have also evolved in the last few years. Until a decade ago, the tip location of FICCs was mostly obtained by radiological methods (either by intraprocedural fluoroscopy or by post-procedural abdominal X-ray). The location of the catheter tip was estimated by its anatomical projection on radiological landmarks.^{41,42} Such radiological methods were quite inaccurate, both in terms of actual location of the tip (e.g. a catheter accidentally inserted in the right lumbar ascending vein could hardly be differentiated by a catheter correctly placed into the inferior vena cava) and in terms of precision (e.g. radiological landmarks may not allow to accurately discriminate if the tip is above or below the renal veins).

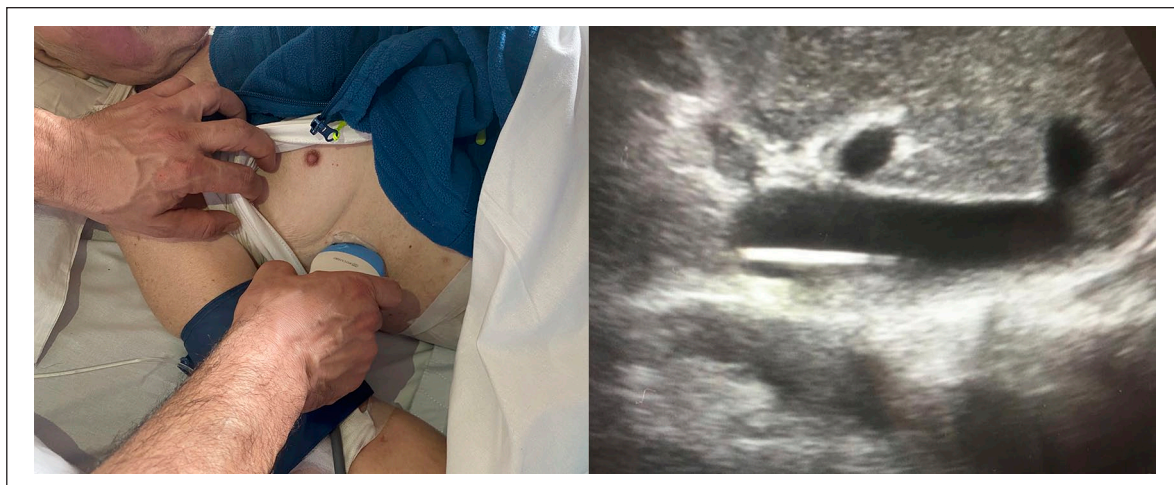


Figure 3. Ultrasound visualization of the tip of the catheter in the sub-diaphragmatic vena cava, using the transhepatic view.

Since 2020, most international guidelines recommend that tip location of central venous catheters ought to be obtained during the maneuver itself.^{8,10,17} Thus, tip location of FICCs by post-procedural abdominal X-ray is currently discouraged because inaccurate, not cost-effective, and unsafe for the patient, since it implies X-ray exposure. Possible options for an intraprocedural assessment of the position of the tip of a FICC in the right atrium or in the inferior vena cava include fluoroscopy, intracavity ECG (IC-ECG), trans-esophageal echocardiography (TEE), and trans-thoracic echocardiography (TTE).

Tip location by fluoroscopy is currently discouraged because inaccurate (since it is based on poorly reliable radiological landmarks), unsafe (since it implies X-ray exposure), expensive, and logistically difficult at bedside.^{8,10,17}

TEE is highly accurate for the tip location of venous catheters with the tip in right atrium or at the cava-atrium junction, but it is useless when the tip is in the inferior vena cava below the diaphragm; also, it is expensive, invasive, and logistically difficult or unfeasible in most situations.^{10,17}

IC-ECG is a simple, safe, accurate, and cost-effective method of intra-procedural tip location, if the tip is expected to be inside the right atrium or at the superior cava-atrial junction. If the tip of the FICC is meant to be in the right atrium, IC-ECG can be successfully utilized both in children²⁸ and in adults.⁴³

On the other hand, TTE—particularly if associated with the so-called “bubble test”^{22,44}—is the ideal intraprocedural method of tip location for FICCs, both in adults and in children, both for tips meant to be in the right atrium and in tips which should stay somewhere inside the inferior vena cava. Adopting a subcostal view (axial or longitudinal) or an apical view, it is possible to obtain an ultrasound visualization of the right atrium; the subcostal views also allow optimal visualization of the junction between atrium

and inferior vena cava.^{22–24} Adopting a transhepatic view, it is also possible to visualize the subdiaphragmatic inferior vena cava, and more precisely the tract included between the renal veins and the hepatic veins.^{45,46} The transhepatic view has been used for years as a “rescue view” in patients with difficult subcostal window,^{47–49} such as in presence of pericardial drainage, abdominal surgical wound, percutaneous endoscopic gastrostomy, ascites, third trimester pregnancy, distention of colon and stomach by gas or enteral nutrition, or non-invasive ventilation. In recent years, the transhepatic view of the inferior vena cava has been applied to the field of venous access, for the purpose of identifying the tip of FICCs.⁴⁵ The maneuver is performed by placing a convex probe (3–8 MHz) or a sectorial probe (2–6 MHz) between the anterior and the middle axillary line at the level of the 9th–10th intercostal space. The marker of the probe is toward the patient’s head. This view uses the liver as acoustic window. Tilting the probe, the inferior vena cava can be visualized in its long axis, from the right kidney up to the junction with the hepatic veins (Figure 3). The intra-procedural tip location of FICCs with the transhepatic view is simple, safe, and accurate (since it allows to directly visualize the catheter inside the vein): it is applicable in 97.6% and feasible in 100% of cases.^{45,46}

The present and future of non-dialysis femoral access

Since the introduction of these novelties in the clinical practice, the world of femoral venous access has become particularly varied and complex. Femoral access is attracting the attention of more and more physicians, in many different populations of patients. When excluding femoral catheters used for dialysis or apheresis (either short-term non-tunneled or long-term tunneled), different choices for

Table 1. Non-dialysis femoral venous access today.

Patients	Device	Indication	Access	Exit site	Tip location method	Preferred securement
Neonates	ECC	Short term	Superficial veins of the lower limb	Peripheral sites	Neo-ECHOTIP	Sutureless
	Non-tunneled FICC	Emergency	CFV	Groin	Not required	Sutureless
	Tunneled FICC	Short/long term	CFV	Mid-thigh	Neo-ECHOTIP	Subcutaneous anchorage
Children	Non-tunneled FICC	Emergency	CFV	Groin	ECHOTIP-Ped	Sutureless
	Tunneled FICC	Short/long term	CFV	Mid-thigh	ECHOTIP-Ped	Subcutaneous anchorage
Adults	Peripheral catheter	Short term	Deep veins of the lower limb	Various sites	Not required	Sutureless
	Non-tunneled FICC	Emergency	CFV	Groin	Not required	Sutureless
	Non-tunneled FICC	Short/long term	SFV	Mid-thigh	ECHOTIP/IC-ECG	Subcutaneous anchorage
	Tunneled FICC	Short/long term	CFV or SFV	Mid-thigh	ECHOTIP/IC-ECG	Subcutaneous anchorage
	FICC-port	Long term	CFV or SFV	—	ECHOTIP	—

ECC: epicutaneo-cava catheter; FICC: femorally inserted central catheter; CFV: common femoral vein; SFV: superficial femoral vein.

Neo-ECHOTIP, ECHOTIP-Ped, ECHOTIP, IC-ECG: see explanation in the text.

Short term: <3–4 weeks; long term: >3–4 weeks.

non-dialysis femoral access are currently available in neonates, in children and in adults, and they are summarized in Table 1.

In neonates, central venous catheters inserted—directly or indirectly—into the femoral veins—include:

(a) epicutaneo-cava catheters (ECC) with access at the lower limbs: these are non-power injectable, small-bore catheters (1–2.7 Fr), preferably in polyurethane, inserted by direct venipuncture of superficial veins of the saphenous system; sometimes they are called “neonatal PICCs,” but probably the best definition is ECC, to differentiate them from the ultrasound-guided PICCs used in children and adults^{50,51}; they do not imply the adoption of ultrasound-guided venipuncture, since they are inserted in very superficial veins, quite visible through the skin, but ultrasound is recommended for the assessment of the final position of the tip, that should ideally be located at the junction between inferior vena cava and right atrium²³;

(b) non-tunneled femorally inserted central catheters (non-tunneled FICCs): that is, power injectable polyurethane large bore catheters (3–4 Fr) inserted into the common femoral vein by ultrasound guided venipuncture, with exit site at the groin. The location of the exit site is relatively disadvantageous in terms of risk of infection. A “pseudo-tunneling” (or “extended subcutaneous route”) may be useful for achieving an exit site slightly more distal to the groin.^{16,52} As for ECCs, also for FICCs tip location must be assessed preferably by ultrasound: the final position of the tip may be either in the subdiaphragmatic inferior vena cava (visualization by a transhepatic view) or at the entrance of the right atrium (visualization by subcostal view).²³

(c) tunneled femorally inserted central catheters (tunneled FICCs): that is, power injectable polyurethane 3–4 Fr catheters inserted by ultrasound guided venipuncture of the common femoral vein, but with the exit site located at mid-thigh, through a short subcutaneous tunnel connecting the puncture site with the exit site. The tip location is the same as for non-tunneled FICCs. Since the use of cuffed catheters is not recommended in neonates, tunneled FICCs should be secured by subcutaneous anchorage (Figure 4). Tunneled FICCs are more reliable than non-tunneled FICCs in terms of duration and risk of complications: the tunneling and the exit site decrease the risk of infection by reducing extraluminal bacterial contamination⁵³; even the risk of thrombosis seems to be reduced.⁵⁴

As recommended by all recent guidelines¹⁰ and textbooks,⁴⁰ the use of small bore tunneled-cuffed silicone catheters (e.g. Broviac catheters, which were typically inserted by “blind” venipuncture of the common femoral vein or by venous cutdown of the saphenous vein) should be strongly discouraged: such catheters are fragile, unreliable in terms of flow and resistance, and usually associated with a high risk of mechanical complications (rupture, tip migration, dislodgment, etc.).

In infants and children, as in neonates, the superficial femoral vein is too small to be cannulated, so that FICCs are always inserted via ultrasound-guided puncture/cannulation of the common femoral vein, with or without tunneling:

(a) non-tunneled femorally inserted central catheters (non-tunneled FICCs): such catheters are typically inserted in emergency. As it happens in emergency,



Figure 4. Tunneled FICC in infant.

maximal barrier precautions are often not adopted; also, the exit site at the groin (inevitable after puncture/cannulation of the common femoral vein) is disadvantageous in terms of bacterial contamination; also, intraprocedural assessment of the location of the tip (ideally, by ultrasound) may not be feasible. For all these reasons, non-tunneled FICCs inserted in emergency should be removed as soon as possible (within 48 h).¹⁰

(b) Tunneled femorally inserted central catheters (tunneled FICCs): these catheters have longer duration and less risk of complications if compared to non-tunneled FICCs, as long as they are in polyurethane and power injectable. The use of fragile cuffed silicone catheters (e.g. Broviac, Hickman, or Groshong) has no clinical justification anymore.^{40,54} The venipuncture should be consistently performed by ultrasound guidance,^{55,56} and the tip location should be intraprocedural, according to the ECHOTIP-Ped protocol.²⁴ The risk of dislodgment should be minimized by using cuffed catheters in polyurethane or by using non-cuffed catheters secured by subcutaneous anchorage (this second option appears to be preferable)⁵⁷ (Figure 5).

In adult patients, several options of femoral access may be considered:

(a) Peripheral femoral catheters (femoral “midline” catheters): anytime the tip of the femoral catheter does not reach the inferior vena cava, the device should be



Figure 5. Tunneled FICC with exit site at mid-thigh (after puncture of the common femoral vein) in a pediatric patient.

regarded as a “peripheral” venous access, that is, not appropriate for the infusion of solutions potentially associated with endothelial damage; peripheral catheters may be inserted by ultrasound guided approach of the popliteal vein or of the saphenous vein or of the femoral veins, and may have a role in palliative care¹⁴ or in situations where threading the catheter through the iliac veins into the inferior vena cava seems to be difficult or impossible (Figure 6).

(b) Non-tunneled FICCs with exit site at the groin: this are typically FICCs inserted in emergency, via ultrasound guided puncture of the common femoral vein, and they should be preferably removed within 48 h, because of the high risk of infection (secondary to the contamination of the groin area); the instability of the catheter and the difficulty in securing it are also associated with a high risk of venous thrombosis and of dislodgment (Figure 7).

(c) Non-tunneled FICCs with exit site at mid-thigh: as discussed above, ultrasound guided puncture of the superficial femoral vein at mid-thigh is associated with an exit site in an area which usually at low risk of contamination²⁶; the risk of thrombosis and the risk of dislodgment also appear to be reduced; this approach is more and more utilized in both hospitalized and non-hospitalized patients with relative or absolute contraindications to the placement of a PICC or a CICC⁵⁸ (Figure 8). The ideal location of the tip should be in the subdiaphragmatic inferior vena cava (ultrasound visualization of the tip in the tract of

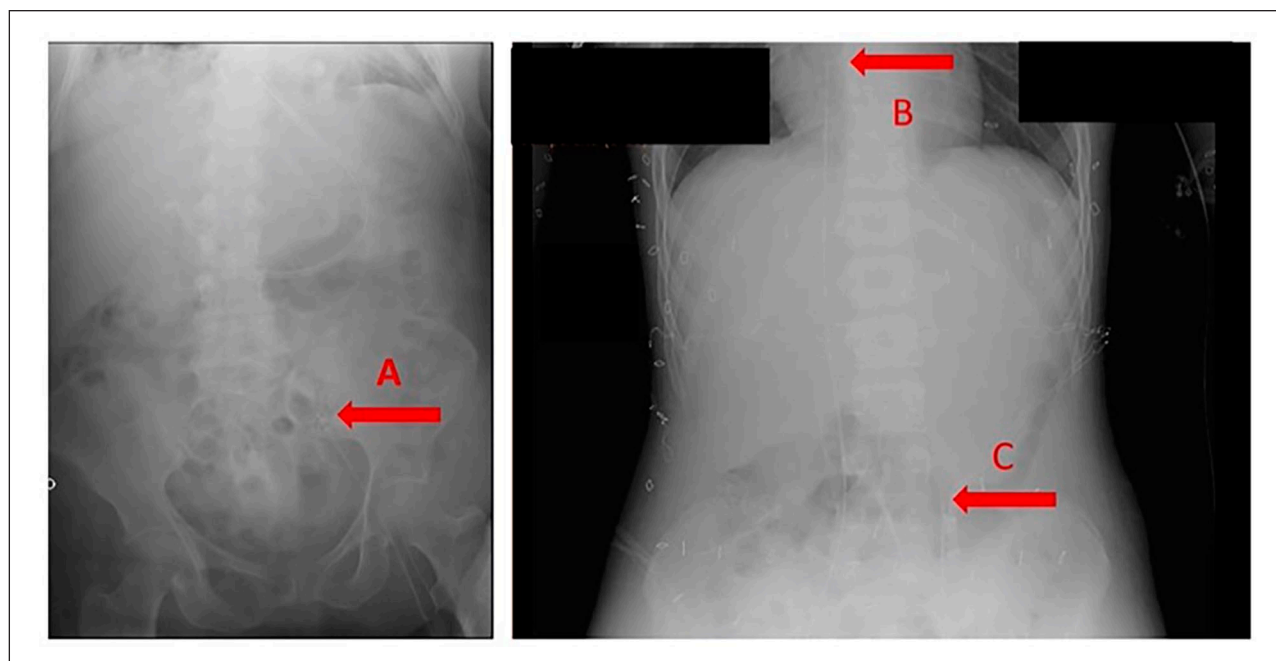


Figure 6. Femoral catheters with tip located (A) in the common iliac vein (femoral “midline” catheter, appropriate only as peripheral venous access), (B) in the right atrium (femorally inserted central catheter=FICC, appropriate as central venous access), and (C) in the left lumbar ascending vein (inappropriate position: to be removed immediately).



Figure 7. Femoral catheter with exit site at the groin.

vena cava between renal veins and hepatic veins, using a transhepatic view with “bubble test”) or in right atrium (Figure 6) (tip location by intracavitary ECG or by ultrasound visualization of the tip using a subcostal or apical view with “bubble test”).

(d) Tunneled FICCs (cuffed or non-cuffed): tunneling should be adopted any time the line is expected to last for a long period. Tunneling may be adopted to achieve an exit site at mid-thigh, or even more distally^{27–29}; tunneling backwards, so to get an exit site in the abdominal area is not recommended, since it is associated with risk



Figure 8. Non-tunneled FICC with exit site at mid-thigh (after puncture of the superficial femoral vein).

of kinking the catheter. In particular, distal third-thigh tunneling may be an option in case of non-cooperative patients to prevent self-removal of the catheter.²⁷ All tunneled FICCs should be in polyurethane and power injectable (as already mentioned, tunneled silicone catheters are currently not recommended anymore).¹⁰ Tip location should be performed during the procedure, with the same methods mentioned for non-tunneled FICCs with exit site at mid-thigh. As already discussed, the risk of dislodgment should be minimized either adopting cuffed catheters, or—even better—securing non-cuffed catheters by subcutaneous anchorage.⁵⁹

(e) FICC ports: when an infrequent access for anti-blastic chemotherapy is required (e.g. every 3 weeks) and there are relative/absolute contraindications to the implantation of a PICC-port or a chest-port, a femoral catheter inserted via the femoral veins can be connected with a reservoir. The most recent strategy is to use 5 Fr polyurethane catheters, preferably inserted in the superficial femoral vein and connected with a very low-profile reservoir (about 8 mm high) placed in a subcutaneous pocket just above the quadriceps muscle. The old method of using bulky reservoirs placed in the abdominal wall or above the iliac crest should be discouraged.

Conclusions

In the past 5 years, a few relevant clinical strategies have radically changed femoral venous access, particularly for the catheters to be used not for dialysis but for infusion and blood sampling: (a) ultrasound guided venipuncture, which have extended the choice of veins available for cannulation; (b) tunneling techniques, which have lowered the risk of infection and thrombosis, mainly related to the exit site at the groin; (c) the adoption of 50–60 cm long catheters, which have increased the possibility of achieving a real “central” location of the tip; (d) ultrasound-based tip location, which has allowed to obtain an intraprocedural, non-invasive assessment of the final position of the tip.

These changes have expanded the indications of non-dialysis femoral access and have reduced the risk of complications.

To the traditional non-emergency indication for FICCs—obstruction of the superior vena cava—many other indications have been added, both for intensive and non-intensive care areas.^{25,35} Whenever the veins of the upper limbs are inaccessible, and a single or double lumen catheter seems to be appropriate, an analysis of risk/benefit ratio may favor a FICC over a CICC. Also, patients with cognitive disorders who may be prone to accidental removal of the central catheter may benefit of an exit site at mid-thigh, or even more distally, far from the reach of their hands. Last, both in some acutely ill and in many palliative care patients, an exit site at mid-thigh (as with a FICC inserted into the superficial femoral vein, or inserted into the common femoral vein and tunneled downwards) may be easier and cleaner to manage. Central catheters via the access to the superficial femoral vein has also been proven to be advantageous in COVID patients ventilated in prone position.³⁵

This extension of indications is mainly secondary to the fact that FICC insertion is nowadays regarded as a procedure with an extremely low intraprocedural and post-procedural risk. The risks of femoral access—both at the time of insertion and during the period of indwelling—have been lowered by the new strategies described above. The risk of

infection is reduced by the possibility of the exit site at mid-thigh, the use of cyanoacrylate glue for sealing the exit site,⁶⁰ and by appropriate intraprocedural strategies of infection prevention (skin antisepsis with 2% chlorhexidine in alcohol and maximal barrier precautions). The risk of catheter-related thrombosis is low, due to several concomitant strategies⁶¹: a proper match between vein diameter and catheter caliber; an accurate intraprocedural assessment of tip location by ultrasound and/or intracavitary ECG^{19,20}; the consistent use of ultrasound guided venipuncture and micro-introducer kits; an adequate stabilization of the catheter at the exit site. Subcutaneous anchorage reduces the risk of dislodgment.^{59,62} The risk of mechanical complications (tip migration, kinking, catheter rupture) and the risk of lumen occlusion are minimized when using polyurethane, power injectable catheters.

As with other types of central catheters, the adoption of all the above precautions should be ensured using a proper insertion bundle—like the SIF protocol¹⁸—and post-procedural management should follow the recommendations of the current international guidelines.^{8,10} Finally, the proper training of the staff, both at insertion and at management, will play the most important role in ensuring an optimal clinical outcome.

Declaration of conflicting interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The authors received no financial support for the research, authorship, and/or publication of this article.

ORCID iDs

Maria Giuseppina Annetta  <https://orcid.org/0000-0001-7574-1311>

Stefano Elli  <https://orcid.org/0000-0002-8785-824X>

Fulvio Pinelli  <https://orcid.org/0000-0002-9926-2128>

Mauro Pittiruti  <https://orcid.org/0000-0002-2225-7654>

References

1. Akaraborworn O. A review in emergency central venous catheterization. *Chin J Traumatol* 2017; 20(3): 137–140.
2. Pittiruti M, Hamilton H, Biffi R, et al. ESPEN guidelines on parenteral nutrition: central venous catheters (access, care, diagnosis and therapy of complications). *Clin Nutr* 2009; 28(4): 365–377.
3. O'Grady NP, Alexander M, Burns LA, et al.; Healthcare Infection Control Practices Advisory Committee (HICPAC). Guidelines for the prevention of intravascular catheter-related infections. *Clin Infect Dis* 2011; 52(9): e162–e193.
4. Marshall J, Mermel LA, Fakih M, et al.; Society for Healthcare Epidemiology of America. Strategies to prevent central line-associated bloodstream infections in acute

- care hospitals: 2014 update. *Infect Control Hosp Epidemiol* 2014; 35(7): 753–771.
5. Buetti N, Marschall J, Drees M, et al. Strategies to prevent central line-associated bloodstream infections in acute-care hospitals: 2022 update. *Infect Control Hosp Epidemiol* 2022; 43(5): 553–569.
6. Parienti JJ, Mongardon N, Mégarbane B, et al. Intravascular complications of central venous catheterization by insertion site. *N Engl J Med* 2015; 373(13): 1220–1229.
7. Böll B, Schalk E, Buchheidt D, et al. Central venous catheter-related infections in hematology and oncology: 2020 updated guidelines on diagnosis, management, and prevention by the Infectious Diseases Working Party (AGIHO) of the German Society of Hematology and Medical Oncology (DGHO). *Ann Hematol* 2021; 100(1): 239–259.
8. Gorski LA, Hadaway L, Hagle ME, et al. Infusion therapy standards of practice, 8th edition. *J Infus Nurs* 2021; 44(1S Suppl 1): S1–S224.
9. Pittiruti M, Van Boxtel T, Scoppettuolo G, et al. European recommendations on the proper indication and use of peripheral venous access devices (the ERPIUP consensus): a WoCoVA project. *J Vasc Access* 2023; 24(1): 165–182.
10. Pittiruti M and Scoppettuolo G. Raccomandazioni GAVeCeLT 2021 per la indicazione, l'impianto e la gestione dei dispositivi per accesso venoso, 2021, <https://www.gavecelt.it/nuovo/sites/default/files/uploads/Raccomandazioni%20GAVeCeLT%202021%20-%20v.2.0.pdf>
11. Manrique-Rodríguez S, Heras-Hidalgo I, Pernia-López MS, et al. Standardization and chemical characterization of intravenous therapy in adult patients: a step further in medication safety. *Drugs R D* 2021; 21(1): 39–64.
12. Boronovo F, Quici M, Gidaro A, et al. Physico-chemical characteristics of antimicrobials and practical recommendations for intravenous administration: a systematic review. *Antibiotics (Basel)* 2023; 12(8): 1338.
13. Gidaro A, Samartin F, Salvi E, et al. Midline peripheral catheters inserted in the superficial femoral vein at mid-thigh: wise choice in COVID-19 acute hypoxemic respiratory failure patients with helmet continuous positive airway pressure. *J Vasc Access*. Epub ahead of print 2 May 2022. DOI: 10.1177/11297298221085450.
14. Ostroff M, Aberger K and Moureau N. Case report: end of life care via a mid-thigh femoral midline catheter. *J Vasc Access* 2023; 24: 809–812.
15. Kammerer T and Brezina T. Cannulation of the popliteal vein as an intraoperative emergency access in prone position: a case report. *J Vasc Access* 2022; 23(5): 816–818.
16. Ostroff MD, Moureau N and Pittiruti M. Rapid Assessment of Vascular Exit Site and Tunneling Options (RAVESTO): a new decision tool in the management of the complex vascular access patients. *J Vasc Access* 2023; 24(2): 311–317.
17. Lamperti M, Biasucci DG, Disma N, et al. European Society of Anaesthesiology guidelines on peri-operative use of ultrasound-guided for vascular access (PERSEUS vascular access). *Eur J Anaesthesiol* 2020; 37(5): 344–376. Erratum in: *Eur J Anaesthesiol*. 2020;37(7):623.
18. Brescia F, Pittiruti M, Ostroff M, et al. The SIF protocol: a seven-step strategy to minimize complications potentially related to the insertion of femorally inserted central catheters. *J Vasc Access* 2023; 24: 527–534.
19. Pittiruti M, Celentano D, Barone G, et al. A GAVeCeLT bundle for central venous catheterization in neonates and children: a prospective clinical study on 729 cases. *J Vasc Access*. Epub ahead of print 9 May 2022. DOI: 10.1177/11297298221074472.
20. Annetta MG, Celentano D, Zumstein L, et al. Catheter-related complications in onco-hematologic children: a retrospective clinical study on 227 central venous access devices. *J Vasc Access*. Epub ahead of print 14 September 2022. DOI: 10.1177/11297298221122128.
21. Brescia F, Pittiruti M, Ostroff M, et al. Rapid Femoral Vein Assessment (RaFeVA): a systematic protocol for ultrasound evaluation of the veins of the lower limb, so to optimize the insertion of femorally inserted central catheters. *J Vasc Access* 2021; 22(6): 863–872.
22. La Greca A, Iacobone E, Elisei D, et al. ECHOTIP: a structured protocol for ultrasound-based tip navigation and tip location during placement of central venous access devices in adult patients. *J Vasc Access* 2023; 24: 535–544.
23. Barone G, Pittiruti M, Biasucci DG, et al. Neo-ECHOTIP: a structured protocol for ultrasound-based tip navigation and tip location during placement of central venous access devices in neonates. *J Vasc Access* 2022; 23(5): 679–688.
24. Zito Marinosci G, Biasucci DG, Barone G, et al. ECHOTIP-Ped: a structured protocol for ultrasound-based tip navigation and tip location during placement of central venous access devices in pediatric patients. *J Vasc Access* 2023; 24(1): 5–13.
25. Annetta MG, Marche B, Dolcetti L, et al. Ultrasound-guided cannulation of the superficial femoral vein for central venous access. *J Vasc Access* 2022; 23(4): 598–605.
26. Bartoli A, Donadoni M, Quici M, et al. Safety of mid-thigh exit site venous catheters in multidrug resistant colonized patients. *J Vasc Access*. Epub ahead of print 18 July 2023. DOI: 10.1177/11297298231188150.
27. Ostroff MD and Pittiruti M. Alternative exit sites for central venous access: back tunneling to the scapular region and distal tunneling to the patellar region. *J Vasc Access* 2021; 22(6): 992–996.
28. Weber MD, Himebauch AS and Conlon T. Use of intracavitary-ECG for tip location of femorally inserted central catheters. *J Vasc Access* 2022; 23(1): 166–170.
29. Elli S, Cannizzo L, Giannini L, et al. Femorally inserted central catheters with exit site at mid-thigh: a low risk alternative for central venous catheterization. *J Vasc Access*. Epub ahead of print 2 November 2022. DOI: 10.1177/11297298221132073.
30. Giustivi D, Gidaro A, Baroni M, et al. Tunneling technique of PICCs and midline catheters. *J Vasc Access* 2022; 23(4): 610–614.
31. Ostroff M, Zauk A, Chowdhury S, et al. A retrospective analysis of the clinical effectiveness of subcutaneously tunneled femoral vein cannulations at the bedside: a low risk central venous access approach in the neonatal intensive care unit. *J Vasc Access* 2021; 22(6): 926–934.
32. Brescia F, Pittiruti M, Spencer TR, et al. The SIP protocol update: eight strategies, incorporating Rapid Peripheral Vein Assessment (RaPeVA), to minimize complications associated with peripherally inserted central catheter insertion.

- J Vasc Access*. Epub ahead of print 27 May 2022. DOI: 10.1177/11297298221099838.
33. Spencer TR and Pittiruti M. Rapid Central Vein Assessment (RaCeVA): a systematic, standardized approach for ultrasound assessment before central venous catheterization. *J Vasc Access* 2019; 20(3): 239–249.
 34. Jones T, Stea N, Stolz U, et al. Ultrasound evaluation of saphenous vein for peripheral intravenous cannulation in adults. *J Vasc Access* 2015; 16(5): 418–421.
 35. Ostroff M, Ismail M and Weite T. Achieving superficial femoral venous access in a critically ill COVID-19 patient in the prone position. *J Vasc Access* 2022; 23(3): 458–461.
 36. Tu Z, Tan Y, Liu L, et al. Ultrasound-guided cannulation of the great saphenous vein in neonates: a randomized study. *Am J Perinatol* 2023; 40(11): 1217–1222.
 37. Wan Y, Chu Y, Qiu Y, et al. The feasibility and safety of PICCs accessed via the superficial femoral vein in patients with superior vena cava syndrome. *J Vasc Access* 2018; 19(1): 34–39.
 38. Zhao L, Cao X and Wang Y. Cannulation of the superficial femoral vein at mid-thigh when catheterization of the superior vena cava system is contraindicated. *J Vasc Access* 2020; 21(4): 524–528.
 39. Annetta MG, Bertoglio S, Biffi R, et al. Management of antithrombotic treatment and bleeding disorders in patients requiring venous access devices: a systematic review and a GAVeCeLT consensus statement. *J Vasc Access* 2022; 23(4): 660–671.
 40. Biasucci DG, Disma NM and Pittiruti M (eds). *Vascular access in neonates and children*. Cham: Springer, 2022.
 41. Xu B, Zhang J, Tang S, et al. Comparison of two types of catheters through femoral vein catheterization in patients with lung cancer undergoing chemotherapy: a retrospective study. *J Vasc Access* 2018; 19(6): 651–657.
 42. Zhang J, Tang S, Hu C, et al. Femorally inserted central venous catheter in patients with superior vena cava obstruction: choice of the optimal exit site. *J Vasc Access* 2017; 18(1): 82–88.
 43. Ma M, Zhang J, Hou J, et al. The application of intracavitary electrocardiogram for tip location of femoral vein catheters in chemotherapy patients with superior vena cava obstruction. *J Vasc Access* 2021; 22(4): 613–622.
 44. Iacobone E, Elisei D, Gattari D, et al. Transthoracic echocardiography as bedside technique to verify tip location of central venous catheters in patients with atrial arrhythmia. *J Vasc Access* 2020; 21(6): 861–867.
 45. Annetta MG, Marche B, Giarretta I, et al. Applicability and feasibility of intraprocedural tip location of femorally inserted central catheters by transhepatic ultrasound visualization of the inferior vena cava in adult patients. *J Vasc Access*. Epub ahead of print 10 February 2023. DOI: 10.1177/11297298231153979.
 46. Annetta MG, Marche B, Mercurio G, et al. Ultrasound based tip location of femorally inserted central catheters into the inferior vena cava: a comparison between the transhepatic and the subcostal view. *J Vasc Access*. Epub ahead of print 30 May 2023. DOI: 10.1177/11297298231178063.
 47. Finnerty NM, Panchal AR, Boulger C, et al. Inferior vena cava measurement with ultrasound: what is the best view and best mode? *West J Emerg Med* 2017; 18(3): 496–501.
 48. Strachinaru M, Bowen DJ, Constatinescu A, et al. Transhepatic echocardiography: a novel approach for imaging in left ventricle assist device patients with difficult acoustic windows. *Eur Heart J Cardiovasc Imaging* 2020; 21(5): 491–497.
 49. Valette X, Ribstein P, Ramakers M, et al. Subcostal versus transhepatic view to assess the inferior vena cava in critically ill patients. *Echocardiography* 2020; 37(8): 1171–1176.
 50. Barone G and Pittiruti M. Epicutaneo-caval catheters in neonates: new insights and new suggestions from the recent literature. *J Vasc Access* 2020; 21(6): 805–809.
 51. Barone G, D’Andrea V, Ancora G, et al. The neonatal DAV-expert algorithm: a GAVeCeLT/GAVePed consensus for the choice of the most appropriate venous access in newborns. *Eur J Pediatr* 2023; 182: 3385–3395.
 52. Benvenuti S, Porteri E, Ceresoli R, et al. Pseudo-tunneling procedure: an advantageous and safe technique for brachial catheters in younger children. *Minerva Pediatr (Torino)*. Epub ahead of print 8 May 2023. DOI: 10.23736/S2724-5276.23.07196-3.
 53. Sheng Y, Yang LH, Wu Y, et al. Implementation of tunneled peripherally inserted central catheters placement in cancer patients: a randomized multicenter study. *Clin Nurs Res*. Epub ahead of print 19 August 2023. DOI: 10.1177/10547738231194099.
 54. Cellini M, Bergadano A, Crocoli A, et al. Guidelines of the Italian Association of Pediatric Hematology and Oncology for the management of the central venous access devices in pediatric patients with onco-hematological disease. *J Vasc Access* 2022; 23(1): 3–17.
 55. Weber MD, Himebauch AS and Conlon T. Utilization of lateral exit sites for femorally inserted central catheters in pediatric patients: a case report and review of the literature. *J Vasc Access*. Epub ahead of print 27 May 2022. DOI: 10.1177/11297298221099138.
 56. Woerner A, Wenger JL and Monroe EJ. Single-access ultrasound-guided tunneled femoral lines in critically ill pediatric patients. *J Vasc Access* 2020; 21(6): 1034–1041.
 57. Crocoli A, Martucci C, Sidro L, et al. Safety and effectiveness of subcutaneously anchored securement for tunneled central catheters in oncological pediatric patients: a retrospective study. *J Vasc Access* 2023; 24(1): 35–40.
 58. Ostroff M, Moureau N and Ismail M. Review and case studies of midhigh femoral central venous catheter placement. *J Assoc Vasc Access* 2018; 23(3): 167–175.
 59. Pinelli F, Pittiruti M, Van Bortel T, et al. GAVeCeLT-WoCoVA consensus on subcutaneously anchored securement devices for the securement of venous catheters: current evidence and recommendations for future research. *J Vasc Access* 2021; 22(5): 716–725.
 60. Pittiruti M, Annetta MG, Marche B, et al. Ten years of clinical experience with cyanoacrylate glue for venous access in a 1300-bed university hospital. *Br J Nurs* 2022; 31(8): S4–S13.
 61. Pinelli F, Balsorano P, Mura B, et al. Reconsidering the GAVeCeLT consensus on catheter-related thrombosis, 13 years later. *J Vasc Access* 2021; 22(4): 501–508.
 62. Pittiruti M, Scoppettuolo G, Dolcetti L, et al. Clinical experience of a subcutaneously anchored sutureless system for securing central venous catheters. *Br J Nurs* 2019; 28(2): S4–S14.