Original research article

JVA The Journal of Vascular Access

Chest-to-arm tunneling: A novel technique for medium/long term venous access devices

The Journal of Vascular Access
1–7

DOI: 10.1177/11297298211026825
journals.sagepub.com/home/jva
SAGE

Maria Giuseppina Annetta[1], Matt Ostroff[2], Bruno Marche[1], Alessandro Emoli[1], Andrea Musarò[1], Davide Celentano[1], Cristina Taraschi[1], Laura Dolcetti[1], Antonio La Greca[1], Giancarlo Scoppettuolo[1] and Mauro Pittiruti[1]

Abstract

Background: Chest-to-arm (CTA) tunneling has been described recently as a technique that allows an optimal exit site at mid-arm even in chronically ill patients with complex clinical issues and challenging problems of vascular access.
Method: We adopted CTA tunneling in oncologic and in non-oncologic patients, in totally implanted and in external devices, for both medium and long-term intravenous treatments. We report our experience with 60 cases of CTA tunneling: 19 patients requiring a totally implantable device, who had bilateral contraindication to venous access at the arm and bilateral contraindication to placement of the pocket in the infra-clavicular area; 41 patients requiring an external central venous catheter, who had bilateral contraindication to insertion of peripherally inserted central catheters or femoral catheters, as well as contraindication to an exit site in the infraclavicular area. All venous access devices were inserted with ultrasound guidance and tip location by intracavitary electrocardiography, under local anesthesia.
Results: There were no immediate or early complications. Patients with CTA-ports had no late complications. In patients with CTA-tunneled external catheters, there were two dislodgments, four episodes of central line associated blood stream infections, and one local infection. There were no episodes of venous thrombosis or catheter malfunction.
Conclusion: Our experience suggests that CTA tunneling is a safe maneuver, with very low risk of complications, and should be considered as an option in patients with complex venous access.

Keywords

Tunneled catheters, totally implantable venous access device, chest-to-arm tunneling, peripherally inserted central catheters, PICC-port–central venous access

Date received: 28 April 2021; accepted: 31 May 2021

Introduction

Central venous catheterization is frequently used for medium- or long-term intravenous treatments. In order to reduce infectious and thrombotic complications, international guidelines recommend that the exit site should be preferably located in a stable and clean area, such as the mid-portion of the arm—when inserting a peripherally inserted central catheters (PICC)—or the infra-clavicular region—when inserting a centrally inserted central catheters (CICC).[1]

These "ideal" insertion sites have become increasingly challenging for the vascular expert, due to the complexity of chronically ill patients (who may present with history of several previous venous cannulations, venous thrombosis, chronic renal failure, metastatic cancer, etc.).

In some patients, the insertion of PICC may be bilaterally contra-indicated by local or systemic issues (poor

[1]Fondazione Policlinico Universitario "A.Gemelli", Rome, Italy
[2]St. Joseph's University Medical Center, Paterson, NJ, USA

Corresponding author:
Mauro Pittiruti, Catholic University Hospital, Largo Francesco Vito 1, Roma 00168, Italy.
Email: mauropittiruti@me.com

caliber of the veins of the upper extremity, long standing paresis with atrophy of the muscles, previous lymphatic dissection of the axilla, chronic renal failure requiring an arterial-venous fistula, etc.). At the same time, the insertion of a CICC (or of a chest-port) may not be compatible with an exit site (or with a subcutaneous pocket) in the infra-clavicular area (presence of pacemaker or of tunneled-cuffed catheter for dialysis, skin alterations, scheduled radiotherapy of the chest area, voluminous breast implants, etc.).

In some of these cases, an alternative exit site—acceptable in terms of stability and low local contamination—might be at mid-thigh, as can be achieved after venipuncture either of the common or of the superficial femoral vein,[2] with or without tunneling. Yet even this approach it is not always feasible because of previous venous thrombosis, morbid obesity, or contraction of the limbs against the abdomen.

A novel tunneling technique has recently been described, which allows the puncture of a central vein (in the supra-clavicular or infra-clavicular area, as in CICC insertion) associated with an exit site at mid arm (as in PICC insertion): the chest-to-arm (CTA) tunneling.

A central puncture with tunneling toward the arm has been first described by Zerati et al.[3]: in two patients with breast cancer, the reservoir of a totally implanted venous access device was placed in the arm, while the catheter was inserted into the internal jugular vein. Some years later, Kehagias and Tsetis[4] has adopted the same technique of CTA tunneling in 36 cancer patients receiving port placement.

This paper offers a retrospective review of 60 venous access devices inserted using CTA tunneling over the past 13 months: this novel technique has been used both in oncologic and in non-oncologic patients, in both totally implanted and external devices, for both medium and long-term intravenous treatments.

Methods

In this retrospective study, the authors collected the data of all venous access devices inserted using CTA tunneling—from January 2020 to January 2021—in two University Hospitals: Policlinico "A.Gemelli" (Rome, Italy), and St. Joseph University Medical Center (Paterson, NJ, USA).

This review was approved by the Ethics Committee of our University Hospitals and carried out according to the STROBE checklist for retrospective cohort studies.

Both totally implanted venous access devices (port) and external catheters inserted in central veins (CICCs) were included, as long as CTA tunneling had been performed.

The general indication to CTA tunneling was the simultaneous presence of (a) relative/absolute bilateral contraindication to PICC insertion, (b) relative/absolute bilateral contraindication to insertion of femorally inserted central catheter (FICC), and (c) relative/absolute bilateral contraindication to placement of the exit site or of the reservoir in the chest area.

The technique of insertion was different in the case of CTA-port and CTA-tunneled CICC.

Insertion technique of CTA-port

All CTA-ports were implanted in a dedicated procedure room, in the outpatients' facilities of the oncology units. All ports consisted of 5Fr polyurethane catheters connected with very low-profile reservoirs, originally marketed as arm-ports (Minimax, Plan-1-Health; or, Dignity, MedComp).

After obtaining an informed consent, the patient is placed in supine or semi-sitting position on the procedure table, with the arms along the body. All procedures are performed using a specific and dedicated insertion pack. A pre-procedural assessment of the veins of the arms (RaPeVA—Rapid Peripheral Vein Assessment)[5] and of cervico-thoracic veins (RaCeVA—Rapid Central Vein Assessment)[6] is performed with a standard ultrasound device (SonoSite Edge II, linear transducer 6–13 MHz). Standard precautions for infection prevention are adopted, including proper hand hygiene, skin antisepsis with 2% chlorhexidine in 70% iso-propylic alcohol extended from the supraclavicular to the infraclavicular down to mid-arm, as well as maximal barrier precautions (beret, mask, sterile gowns and gloves, wide sterile drapes over the patient, sterile cover for the probe). After ultrasound visualization of the vein and local infiltration with 0.75% ropivacaine, puncture and cannulation of the central vein are performed using real time ultrasound guidance and micro-introduction kits (21 G needle and 0.018″ nitinol guide wire). Central veins used for cannulation include the axillary vein in the infraclavicular area and the internal jugular or subclavian or brachiocephalic vein in the supraclavicular area. After venous cannulation with the nitinol guidewire, a 5.5Fr micro-introducer-dilator is inserted and then a 5Fr catheter is threaded through the introducer, according to the modified Seldinger technique. The direction of the catheter is assessed by ultrasound using the linear probe (ultrasound-based "tip navigation") and the catheter tip is located at the cavo-atrial junction using the intracavitary ECG method. The next phase of the procedure is the preparation of the tunnel and of the subcutaneous pocket for the reservoir, by local infiltration with 0.2% ropivacaine. The pocket is placed on the lateral side of mid-arm. In most cases, one tunnel from the site of venipuncture to the deltopectoral groove and a second tunnel down to the pocket are required. The catheter is threaded through the subcutaneous tunnels with a "retrograde" technique (Figure 1) and connected to the reservoir (Figure 2). After flushing the port with saline, so to rule out any potential kinking of the catheter, the pocket incision is closed with

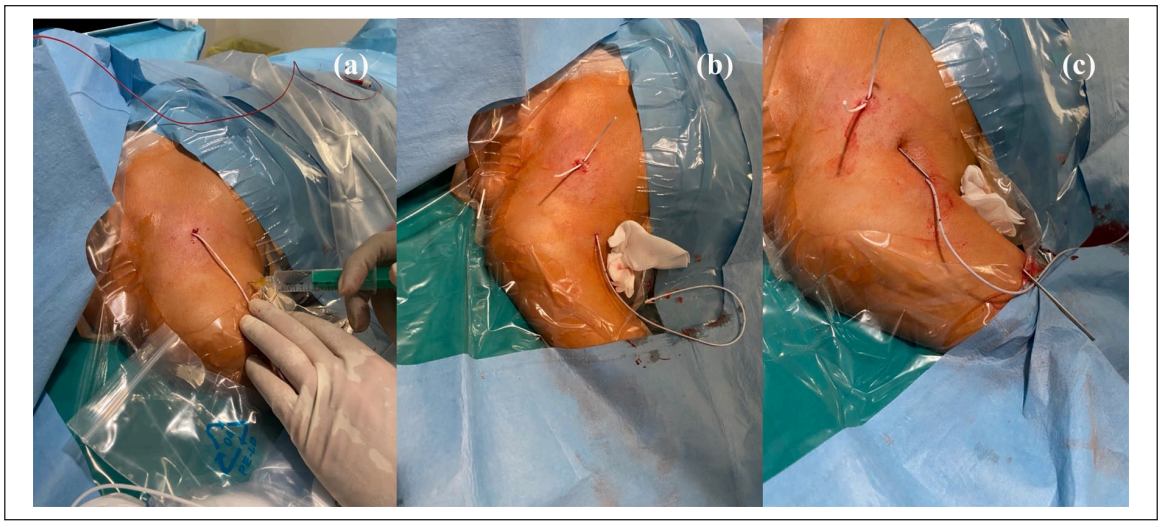

Figure 1. Insertion of a chest-to-arm port: the catheter is inserted in the axillary vein (a), then threaded through a first tunnel to the delto-pectoral groove (b) and via a second tunnel to the arm (c).

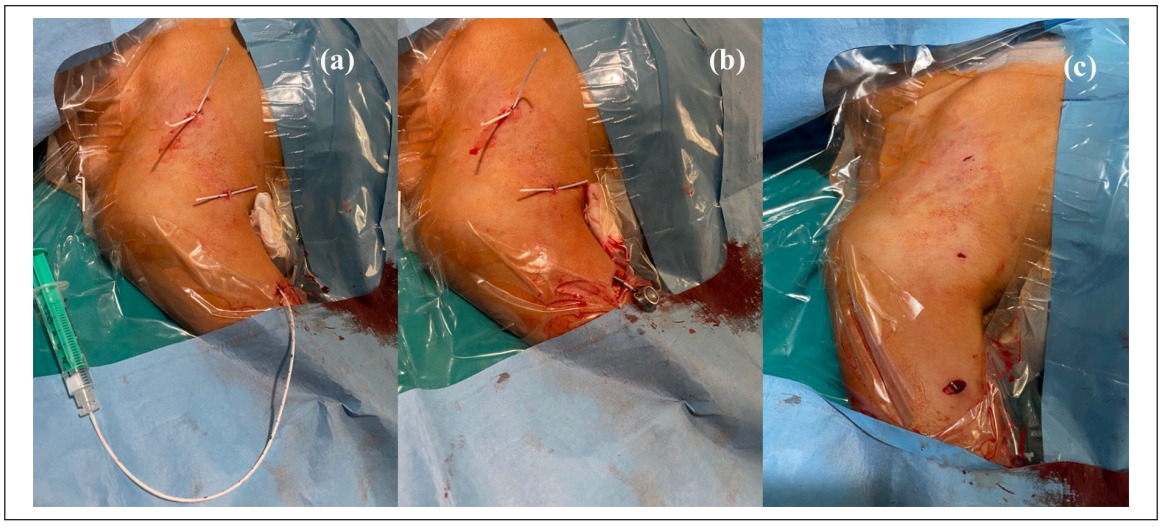

Figure 2. Insertion of chest-to-arm port: the catheter is flushed (a) and connected to the reservoir (b); the reservoir is placed in a pocket at mid-arm (c).

intradermal absorbable sutures (4-0 Monocryl, Ethicon) and cyanoacrylate glue.

Insertion technique of CTA-tunneled CICCs

In all patients receiving CTA-tunneled CICCs, we used pressure injectable polyurethane non-valved catheters (4–4.5 Fr single lumen or 5–5.5 Fr double lumen, 50–60 cm long) originally marketed as PICCs (Synergy CT, Healthline; ProPICC, Medcomp; Celsite PICC, BBraun; ChloraGard PICC, Arrow). The procedure was performed bedside either with a wireless probe (Cerbero, ATL; linear transducer: 7.5–10 MHz) or with a standard ultrasound device (SonoSite Edge II, linear transducer 6–13 MHz).

All procedures are performed using a specific and dedicated insertion pack. Following RaCeVA,[6] ultrasound guided puncture/cannulation of the central vein is performed after skin antisepsis with 2% chlorhexidine in 70% iso-propylic alcohol, using maximal barrier precautions. After a subcutaneous injection of 0.75% ropivacaine or 1% lidocaine, the central vein (axillary, jugular, subclavian, or brachiocephalic vein) is cannulated using real-time ultrasound guidance and micro-introduction kits (21G needle, floppy straight tip 0.018″ nitinol guide wire and micro-introducer-dilator). The main difference from the CTA-port is that the CTA-tunneled CICC employs an "anterograde" tunneling technique, preparing a tunnel connecting the site of venipuncture (in the supra- or infra-clavicular area) with

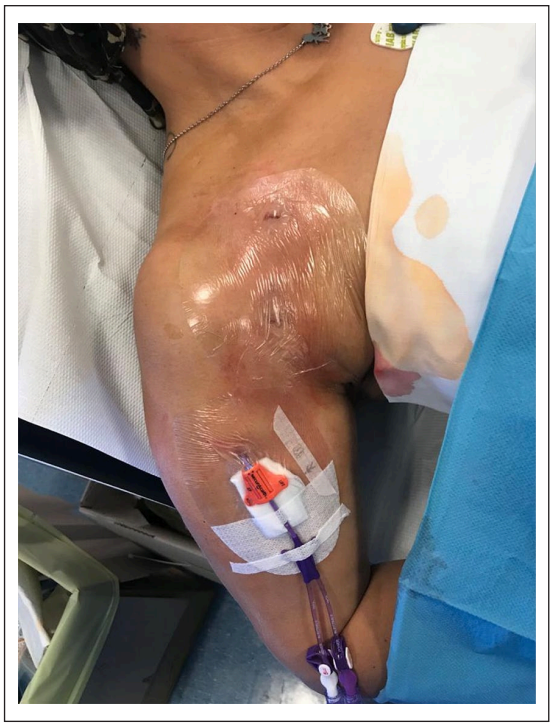

Figure 3. Chest-to-arm tunneled 5Fr double lumen catheter.

Table 1. Patient population.

Total number of patients	60
Age range (years)	24–91
Gender	
Female	27
Male	33
Type of venous access device	
CTA-port	19
CTA-tunneled CICC	41
Main indications to CTA tunneling	
Physical spasticity	19
Chronic renal failure in dialysis	11
Tracheostomy	10
Bilateral mastectomy	4
Cetuximab	4
Patient's preference	3
Orthopedic collar/corset	3
COVID patients	2
Thoracic skin cancer	2
Scleroderma	1
Pacemaker	1

CTA: chest-to-arm; CICC: centrally inserted central catheters.

the planned exit site (at mid-arm, on the lateral border). As the catheter gets to the site of venipuncture, it is trimmed according to a length estimation based on surface landmarks, and then introduced into the vein through a micro-introducer (modified Seldinger technique). The correct tip location is verified by intracavitary ECG, the maximal P wave corresponding to the cavo-atrial junction. In patients with atrial fibrillation, tip location is assessed by the modified intracavitary ECG method[7] combined with ultrasound-based tip location.[8] After tip confirmation, the catheter is secured with a sutureless securement device and the exit site is sealed with cyanoacrylate glue and protected with a semipermeable transparent dressing (Figure 3).

All relevant data related to the insertion procedure were consistently recorded, according to our hospital policies, and outcomes were retrieved for this retrospective analysis. All major catheter-related complications occurring during hospitalization (infection, venous thrombosis, catheter dislodgment, irreversible lumen occlusion) were reported and recorded. The diagnosis of catheter-related blood stream infection (CRBSI) was based on paired cultures (from the lumen of the catheter and from the peripheral blood), according to the method of delayed time to positivity (DTP)[9]; the diagnosis of catheter-related venous thrombosis was based on ultrasound examination of the veins, performed only in case of local signs or symptoms suggestive of venous thrombosis.

Results

In this two-centers retrospective analysis, from January 2020 to January 2021, a total of 60 CTA-tunneled venous access devices were inserted in 60 patients (Table 1): 19 CTA-ports for antiblastic chemotherapy, and 41 CTA-tunneled CICCs for medium to long-term intravenous treatment.

The indication to a medium or long-term venous access device was chemotherapy (19 patients), referral to nursing facilities (18 patients), antibiotic therapy (15 patients), or parenteral nutrition (8 patients).

The clinical indications for inserting a CTA-port (i.e. bilateral contraindication to PICC port + bilateral contraindication to placement of the pocket in the infra-clavicular area) are listed in Table 2. The clinical indications for inserting a CTA-tunneled CICC (i.e. bilateral contraindication to PICC or FICC insertion + contraindication to an exit site in the infraclavicular area) are listed in Table 3.

All the patients were adults (age ranging 24–91 years old): 27 females and 33 males.

All CTA-ports were connected to 5Fr polyurethane catheters. On the other hand, CTA-tunneled CICCs were polyurethane catheters of different calibers: 4Fr ($n=11$), 4,5Fr ($n=7$), 5Fr ($n=10$), 5,5Fr ($n=13$).

The central vein chosen for cannulation was either the axillary vein by infra-clavicular approach ($n=31$), or the brachiocephalic vein ($n=12$), or the internal jugular vein ($n=9$), or the subclavian vein by supraclavicular approach ($n=7$), or the external jugular vein by supraclavicular approach ($n=1$). Ultrasound guided venipuncture was adopted in all cases, using different techniques (depending

Table 2. Clinical indications to CTA-port in 19 patients.

Number of patients	Clinical indication
4	Bilateral mastectomy with previous axillary dissection + planned radiotherapy of the chest area
4	Head and neck cancer + relative contraindication to chest port (planned infusion of cetuximab) + contraindication to PICC-port (small veins of the arm)
3	Metastatic cancer + collar and corset covering the infraclavicular area (PICC-port contraindicated because of underarm straps)
2	Breast cancer + previous history of contralateral breast cancer + chest port previously implanted and removed
2	Thoracic skin cancer + previous reconstructive surgery with cutaneous flap + contraindication to PICC-port (small veins of the arm)
1	Refusal of chest port (professional bassoon player) + contraindication to PICC-port (small veins of the arm)
1	Scleroderma + previous thrombosis of the right jugular and brachiocephalic vein + corset + severe limitation of arm movements
1	Pacemaker in the right infraclavicular area + very small veins on the left side, both at the arm and in the supra-infraclavicular area (<4 mm)
1	Chronic renal failure with non-functioning arterial-venous fistula at left arm + previous thrombosis of right jugular vein + dialysis catheter in right common femoral vein + pacemaker in left infraclavicular area

CTA: chest-to-arm.

Table 3. Clinical indications to CTA-tunneled CICC in 41 patients.

Number of patients	Clinical indication
19	Non-collaborative patients with severe physical spasticity (both arms flexed and contracted above the chest; legs contracted against the abdomen)
10	Chronic renal failure patients with dialysis catheter on the right internal jugular vein + planned tunneled-cuffed dialysis catheter or pacemaker on the left side + previous thrombosis of both femoral veins
10	Tracheostomy secretions leaking on the chest + previous multiple cannulations of femoral veins (common or superficial) + bilateral unavailability of veins at the arm
2	COVID patients with tracheostomy secretions + femoral thrombosis + local contraindications to PICC

CTA: chest-to-arm; CICC: centrally inserted central catheter.

on the vein): short axis out-of-plane ($n=31$), long axis in-plane ($n=20$), short axis in-plane ($n=9$). Central veins were cannulated on the left side in 33 patients and on the right side in 27 patients.

Tip location was performed by intracavitary ECG in 55 patients. In five patients with atrial fibrillation, the position of the tip was assessed combining the "modified" intracavitary ECG technique[7] and ultrasound-based tip location using the "bubble test."[8]

The median length of the whole tunnel (from puncture site to exit site or from puncture site to pocket) was 25 cm, ranging from 20 to 30 cm.

The exit site and the skin incisions were sealed with cyanoacrylate glue in all patients (100%), both for CTA-ports and CTA-tunneled CICCs. As regards CTA-tunneled CICCs, 25 out of 41 catheters were secured by subcutaneous anchorage (Securacath, Interrad).[10,11]

Most patients completed the scheduled intravenous treatment.

No insertion-related complication was reported.

All 19 CTA-ports (100%) are still being used at the moment of preparation of this manuscript, with no complication reported (no local or systemic infection, no symptomatic thrombosis, no irreversible lumen occlusion).

As regards the 41 CTA-tunneled CICCs, in the medium-term follow-up, seven venous access devices were lost before completion of the treatment (17%) (two accidental removals; four central line associated blood stream infections; one tunnel infection without blood stream infection). We have no long term follow-up of 18 CTA-tunneled CICCs in patients transferred to nursing facilities (44%). We have evidence that the rest of the CTA-tunneled CICCs ($n=16$, 39%) completed the scheduled treatment without complications. During the time of hospitalization, no CTA-tunneled CICCs had symptomatic venous thrombosis or irreversible lumen occlusion.

Discussion

Central venous access devices placement can be challenging even for a vascular access expert, due to the increasingly complexities of chronically ill patients (advanced metastatic cancer, long term history of total parenteral nutrition, chronic renal failure, abnormal postures due to

previous ischemic or hemorrhagic stroke, history of multiple central venous catheters or previous venous thrombosis, etc.).

Over the past 15 years, the use of ultrasound has assisted the clinicians in the assessment of the most appropriate vein reducing the risk of both immediate and late complications.[12]

International guidelines recommend the mid-arm and the infra-clavicular regions as the preferred sites for the least risk of infective and thrombotic complications. These same regions are also the preferred sites for the patients requiring totally implanted vascular devices, either PICC-ports[13,14] or chest ports.

Though, insertion of PICC and PICC-ports may be limited in patients with small vein caliber of the arm or with other local issues (venous thrombosis, arm paresis, previous axillary nodes dissection, etc.) and in patients with chronic renal failure possibly requiring an arterial-venous fistula.

Also, location of the exit site (for CICCs) or of the pocket of the reservoir (for chest ports) in the infraclavicular region may be limited due to local issues (pacemaker, skin alterations, orthopedic corsets, etc.) or to the preference of the patient.

The CTA tunneling technique is a safe and viable option for difficult vascular access patients when direct venipuncture at the arm is not appropriate and when the infraclavicular area is unavailable. It was described by Zerati et al.[3] in two breast cancer patients requiring ports for chemotherapy but with contraindications to positioning the reservoir on the chest (diffuse radiodermatitis and morbid obesity). The CTA-ports were performed in an operating room with local anesthesia associated to intravenous sedation. The veins cannulated were the internal jugular vein and the subclavian vein. Both the procedures were performed under fluoroscopic guidance, which is now recognized as less effective and less safe than other methods of tip location.

Few years later, Kehagias and Tsetis[4] used the CTA technique for ports, implanting the reservoir in the inner part of mid-arm. The main reason for adopting the CTA technique was a cosmetic concern: the reservoir at the arm is well concealed and does not interfere with the daily activities. The authors implanted ports with catheters of large size (7–8 Fr) in the internal jugular vein and the subclavian vein. These authors used fluoroscopy, which is not considered optimal for tip navigation and tip location in terms of safety, accuracy, and cost-effectiveness.

This retrospective study is the first one in which CTA tunneling has been adopted using safe and accurate state-of-the-art methods such as ultrasound and intracavitary ECG for all crucial aspects of the procedure (choice of the vein, venipuncture, tip navigation, tip location). Also, all procedures were performed in a safe and cost-effective environment (bedside or dedicated procedural room), avoiding expensive and time-consuming strategies such as use of a radiology suite or an operating theater. Furthermore, all procedures were minimally invasive and performed under local anesthesia, with no need for sedation or general anesthesia, even when multiple tunneling was required.

Patient's preference was particularly important in young cancer patients requiring port, who had personal reasons for desiring to avoid a reservoir in the infraclavicular area. PICC-ports are probably the best choice in young patients with breast cancer,[13,14] but when they are not feasible, CTA-ports are an alternative option, particularly if using the same very low-profile reservoirs used as PICC-ports, locating the pocket in the lateral portion of the arm.

While in the study by Kehagias and Tsetis[4] the main reason for CTA tunneling was based on cosmetic concerns, this study shows many other issues which may contraindicate the exit site or the reservoir in the infraclavicular area: pace-maker or indwelling defibrillators, tunneled-cuffed dialysis catheters, scheduled treatment with Cetuximab (often associated with risk of folliculitis localized in the chest area), presence of a support collar or orthopedic vest with supports on shoulders, previous thoracic skin cancer with previous skin reconstructive surgery and cutaneous flap, presence of a collar tracheostomy with secretions leaking to the chest wall, etc. These patients had simultaneous contraindications to placement of the exit site or of the reservoir at the arm (as PICC or PICC-ports) or in the femoral area (see Tables 2 and 3).

The data of the present study suggest that CTA tunneling is a safe maneuver, with very low risk of complications.

There were no complications reported in 19 patients with CTA-port placement. Interestingly, only very low-profile reservoirs connected to small bore catheters (5Fr) were used, consistently implanted with state-of-the-art methods for infection prevention, venipuncture, and tip location.

In CTA-CICCs (41 patients), no immediate/early complications were reported. The very low percentage of accidental catheter removal (2 patients) may be attributed to the tunneling to the arm, providing stability of care and maintenance, and not easily reachable for the patients. The use of a subcutaneously anchored securement (25 patients) may have contributed to the low incidence of dislodgment. All four patients with CLABSI were on parenteral nutrition: as DTP was not performed, we have no evidence that these were actual CRBSI. The exit site at mid-arm and the presence of the tunnel may have contributed to the low infection rate, minimizing the risk of bacterial contamination by the extraluminal route. During the time of hospitalization, no CTA-tunneled CICC had irreversible lumen occlusion, despite the small caliber of the catheters (4–5.5 Fr). Finally, no cases of symptomatic venous thrombosis were reported in our series of patients. The use of small-

bore catheters inserted in large veins of the supra/infraclavicular area may partially explain this finding.

Limitations of the study

The main limitations of this study are: (a) it is a retrospective study, (b) a percentage of CTA-tunneled CICCs were lost at long term follow-up, (c) the coagulation state of the patients—which might be a relative/absolute contraindication to tunneling—was not consistently recorded or reported.

Impact to clinical practice

CTA-ports should be considered in patients with bilateral contraindication to PICC port and bilateral contraindication to placement of the pocket in the infra-clavicular area. CTA-tunneled CICCs should be considered in patients with bilateral contraindication to PICC or FICC insertion and contraindication to an exit site in the infraclavicular area.

Conclusions

CTA tunneling is a relatively novel methodology, which may be useful in patients with complex intravascular access issues.

The data of this retrospective review suggest that the use of ultrasound and intracavitary ECG makes the procedure of chest-to-arm tunneling safe and minimally invasive: CTA-tunneled CICCs can be inserted at bedside and CTA-ports in a dedicated procedural room, with maximal safety and cost-effectiveness.

Author contributions

All authors were involved in the clinical insertion of the devices and in the retrieval of information and data used in the review. The paper has been conceived and written in its main draft by MGA, MP, and MO. All the authors approved the final version of the manuscript.

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

Matt Ostroff https://orcid.org/0000-0001-5417-5621
Mauro Pittiruti https://orcid.org/0000-0002-2225-7654

References

1. Gorski LA, Hadaway L, Hagle ME, et al. Infusion therapy standars of practice. *J Infus Nurs* 2021; 44(1S): S1–S224.
2. Annetta MG, Marche B, Dolcetti L, et al. Ultrasound-guided cannulation of the superficial femoral vein for central venous access. *J Vasc Access*. Epub ahead of print 21 March 2021. DOI: 10.1177/11297298211003745.
3. Zerati AE, Wolosker N, da Motta-Leal-Filho JM, et al. Totally implantable venous catheters: insertion via internal jugular vein with pocket implantation in the arm is an alternative for diseased thoracic walls. *J Vasc Access* 2012; 13(1): 71–74.
4. Kehagias E and Tsetis D. The "Arm-to-Chest Tunneling" technique: a modified technique for arm placement of implantable ports or central catheters. *J Vasc Access* 2019; 20(6): 771–777.
5. Emoli A, Cappuccio S, Marche B, et al. The ISP (safe insertion of PICCs) protocol: a bundle of 8 recommendations to minimize the complications related to the peripherally inserted central venous catheters (PICC). *Assist Inferm Ric* 2014; 33(2): 82–89
6. 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.
7. Calabrese M, Montini L, Arlotta G, et al. A modified intracavitary electrocardiographic method for detecting the location of the tip of central venous catheters in atrial fibrillation patients. *J Vasc Access* 2019; 20(5): 516–523.
8. 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.
9. Mermel LA, Allon M, Bouza E, et al. Clinical practice guidelines for the diagnosis and management of intravascular catheter-related infection: 2009 update by the Infectious Diseases Society of America. *Clin Inf Dis* 2009; 49: 1–45.
10. 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.
11. Pinelli F, Pittiruti M, Van Boxtel 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*. Epub ahead of print 2 July 2020. DOI: 10.1177/1129729820924568.
12. 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.
13. Bertoglio S, Cafiero F, Meszaros P, et al. PICC-PORT totally implanted vascular access device in breast cancer patients undergoing chemotherapy. *J Vasc Access* 2020; 21(4): 460–466.
14. Xu H, Chen R, Jiang C, et al. Implanting totally implantable venous access ports in the upper arm is feasible and safe for patients with early breast cancer. *J Vasc Access* 2020; 21(5): 609–614.