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Central venous accesses for dialysis: innovations in recent years

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Renal replacement therapy

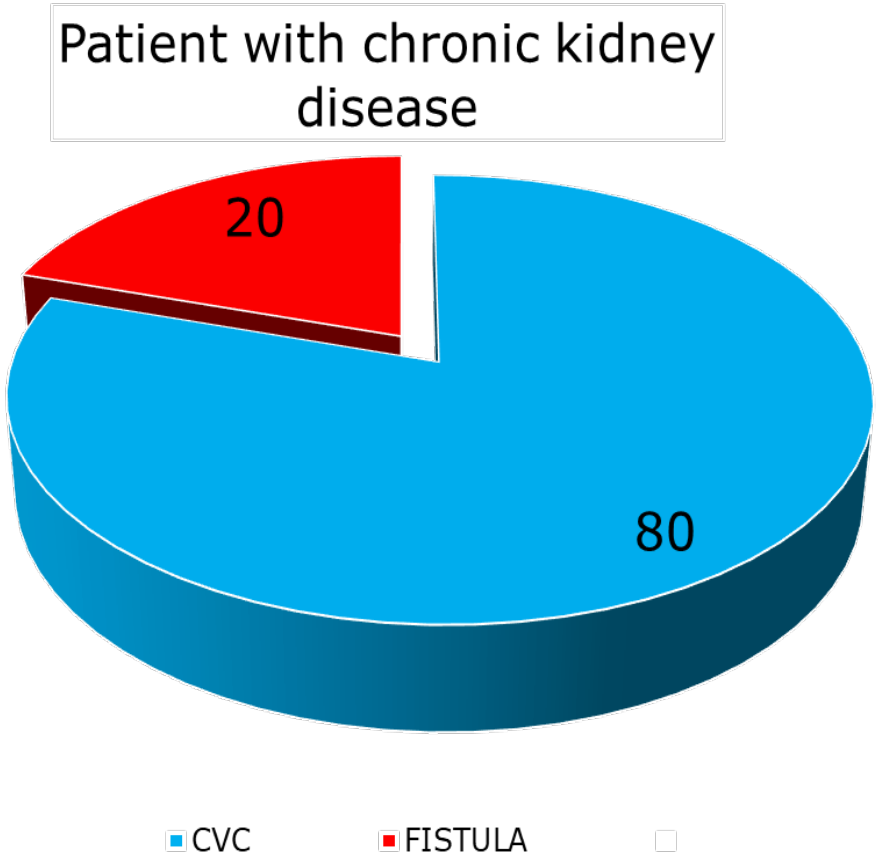
Comparison of types of access

Access Type	**Arteriovenous Fistula**	**Arteriovenous Graft**	**Central Venous Catheter**
PRO	Lasts longer Not prone to infection Excellent blood flow Less likely to clot Ability to shower Normal daily use of arm	Excellent blood flow Ability to shower Normal daily of use of arm Needs 2 weeks to mature	Immediate use No needles
CONS	Prone to stenosis Needs 1–4 months to mature Needs needles to connect	Does not last as long as AVF Prone to infection	Usually temporary Prone to infection

There is no right or wrong method of access. It is about the right access, in the right patient, at the right time, for the right reasons…

Dialysis Catheter

- AVF/AVG are to be created prior to the need for hemodialysis but **catheter-based dialysis** remains the most common first line approach.
- 80% of patient with chronic kidney disease initiate hemodialysis with a central venous catheter(CVC) (1)
- The CVC is the least desirable form of vascular access because of its 2- to 3-fold higher risk of morbidity and mortality burden (2).
- 2 most common complications: CVC dysfunction and bloodstream infection.



1. United States Renal Data System. 2023 USRDS Annual Data Report: Epidemiology of Kidney Disease in the United States. National Institutes of Health, National Institute of Diabetes and Digestive and Kidney Diseases, Bethesda, MD; 2023.
2. Ravani P, Quinn R, Oliver M, et al. Examining the association between hemodialysis access type and mortality: the role of access complications. Clin J Am Soc Nephrol. 2017;12(6):955-964.

CVC dysfunction

Early CVC dysfunction

- Kinking or catheter tip malposition

Late CVC dysfunction

- platelet activation and aggregation

A functioning vascular access is key to providing adequate hemodialysis therapy.

The 2019 KDOQI guideline defines catheter dysfunction as the failure to maintain the prescribed extracorporeal blood flow required for adequate hemodialysis without lengthening the prescribed dialysis treatment time.

Catheter material, luminal design, and tip design

venous port catheter

non-coring special puncture cannula

improved quality of life

Catheter configuration

Straight,
Precurved
Alphacurve

INSERTION

- Retrograde
- Anterograde
- over the-wire-placement
- modified Seldinger technique

FRENCH SIZES

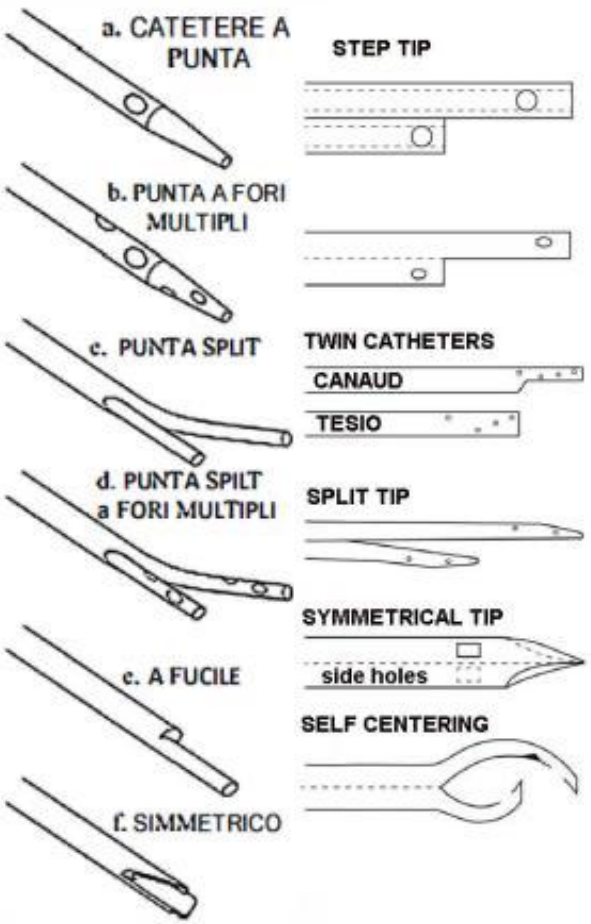
10-16F

MATERIAL

Polyurethane
Silicone

Hub Sutureless compatible

TIP DESIGN



INTERNAL LUMEN DESIGN

Circle "C"

Agarwal AK. Maintenance of blood flow rate on dialysis with self-centering CentrosFLO catheter: A multicenter prospective study. Hemodialysis International 2016; 20:501–509

CVC dysfunction requiring catheter removal based on the catheter tip design

- Symmetric 9,2%
- Step 13,9%
- Split 8,3%

- The side holes on the catheter tip preserve lumina patency in case the end hole is obstructed by a clot or fibrous sheath.

- higher incidence of catheter dysfunction with step tip catheters despite a larger luminal size (15.5F) compared to symmetric and split tip catheters (14.5F).

Lazarus B, Polkinghorne KR, Gallagher M, et al, on behalf of the REDUCCTION investigators. Tunneled hemodialysis catheter tip design and risk of catheter dysfunction: an Australian nationwide cohort study. Am J Kidney Dis. 2024;83(4):445-455.

The ideal double-lumen CVC

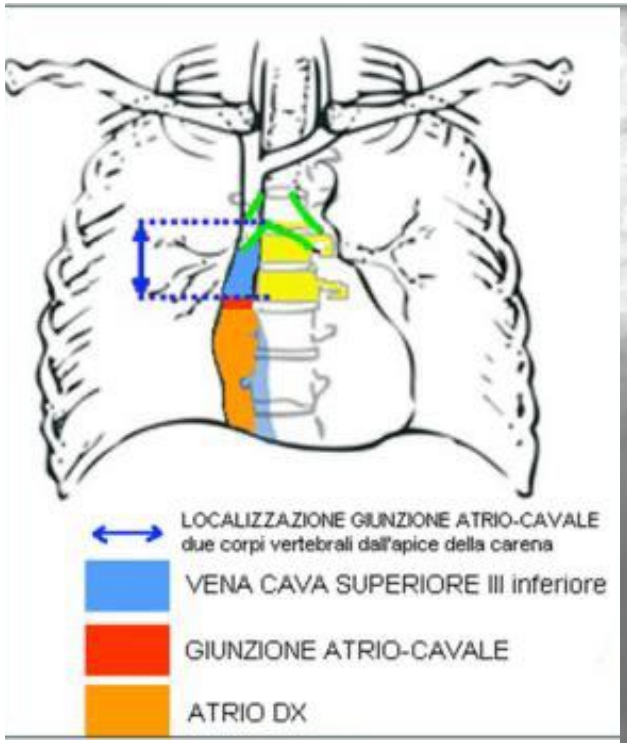
- biocompatible,
- support high blood flow rate without collapsing,
- prevent thrombosis and fibrous sheathing,
- minimize tissue injury during insertion,
- reduce recirculation,
- offer long-term access for sustained hemodialysis therapy

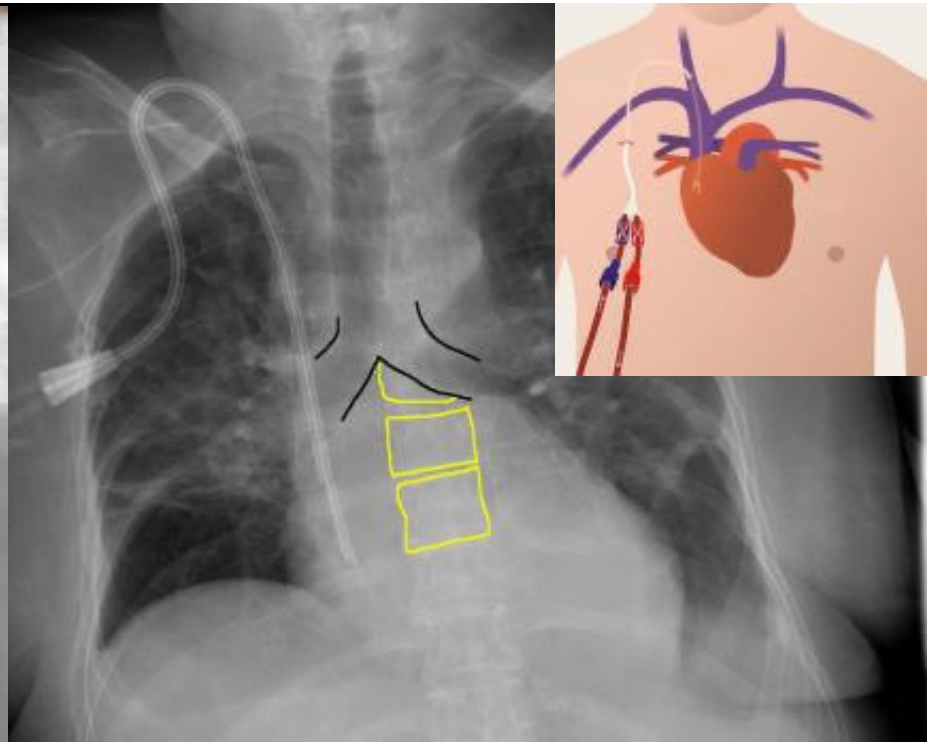
- Future CVC designs, materials and coatings should also focus on the impact of CVC on the development of central stenosis, infection risk, vessel injury, and/or thrombosis.

The 2019 NKF-KDOQI suggests that the choice of tunneled HD CVC type and design be based on the clinician's discretion and best clinical judgment (1).

1. Lok CE, Huber TS, Lee T, et al. National Kidney Foundation. KDOQI Clinical Practice Guideline for Vascular Access: 2019 Update. Am J Kidney Dis. 2020;75(4 Suppl 2):S1-S164.

The tip position





- mid right atrium
- Proper location of the CVC tip is at the mid right atrium to avoid vessel and right atrial trauma and consequent complications
- Insertion length: tip to cuff 55 cm, tip to hub 60 cm

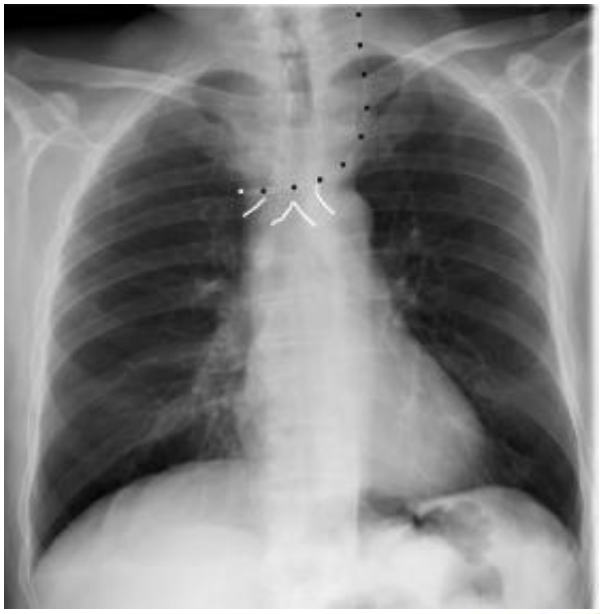
When a CVC fails to support the prescribed extracorporeal blood flow :

Reversal of ports

- can increase the recirculation rate and affect solute clearance.
- A potential solution to reduce recirculation with a step tip catheter can be increasing the distance between arterial and venous tip placement of the arterial tip in the superior vena cava

Usage of thrombolytic agents

- symmetric tip catheters tend to maintain longer patency compared to step tip catheters with reduced thrombolytic usage



left-sided CVC

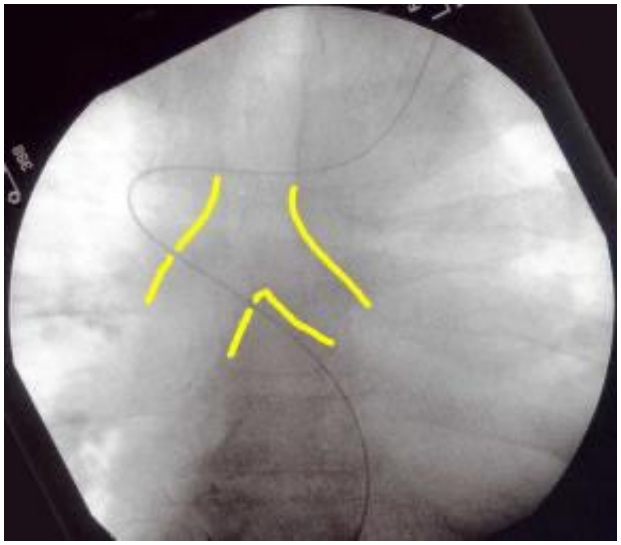
Perform at the bedside subcutaneously tunneled centrally inserted dialysis catheter

- placement is traditionally performed with fluoroscopy in the interventional radiology suite or in the operating theatre
- reduce radiation exposure (fluoroscopy)

KDOQI 2019 considers it reasonable that if fluoroscopy is not used to insert a tunnelled CVC, **alternative imaging** is used to ensure that the CVC tip has been correctly placed.

Challenges for tunneled dialysis catheter placement

- Jugular approach



left sided jugular

- Femoral approach

Catheter tip confirmation via the femoral approach can be achieved with ultrasound through the transhepatic view, or ECG

Pre-procedural assessment

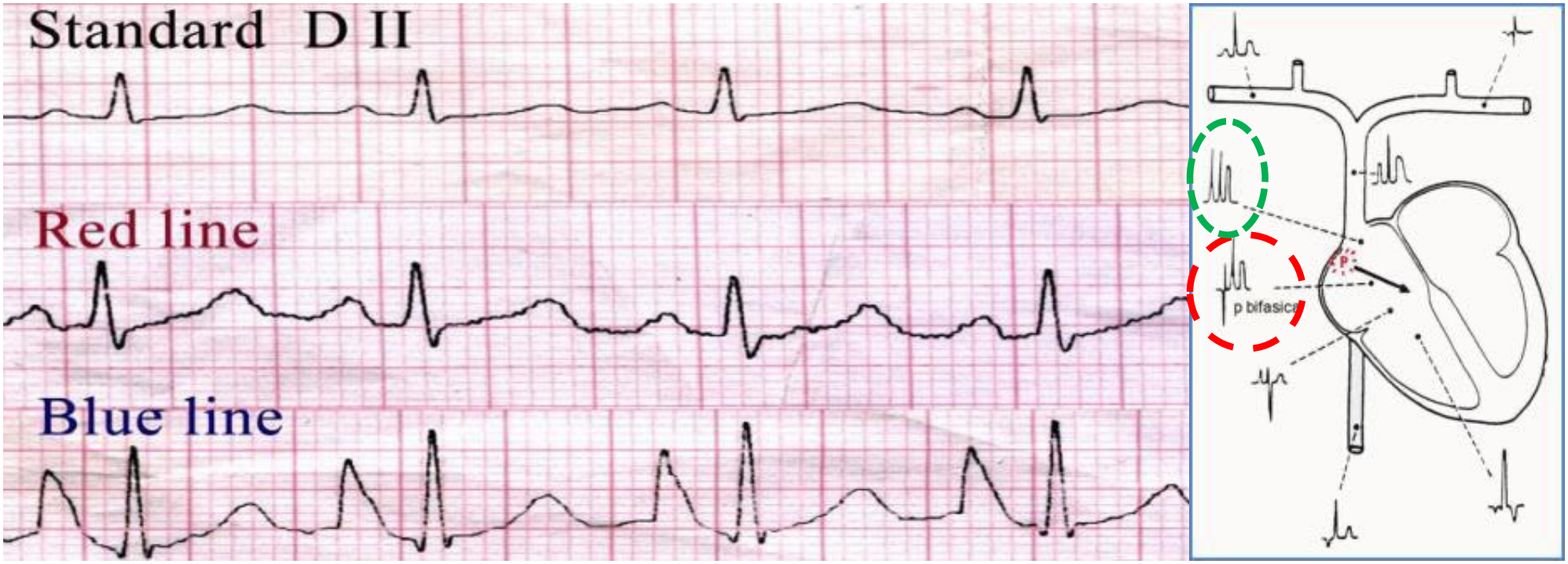
- **Inspection**

- signs of recent venous catheterisation, presence of hair, facial hair
- Presence of collateral veins (chest wall or pelvic region)
- Location and route of the external jugular vein
- Body habitus: short neck, skin folds at the neck or groin
- Skin lesions
- Edema of the lower limbs
- Presence of implanted cardiac or neurosurgical devices

- Ultrasound assessment of the veins (jugular, brachiocephalic and femoral) and the planned venous pathway (RaCeVA and RaFeVA rapid central and femoral assessment protocols). Vein caliber, compressibility, presence of echogenic material.
- Laboratory tests: haemocoagulative status, INR ideally <1.5, and platelet count >50,000 nL
- Baseline ECG and cardiac rhythm assessment

Intravenous Electrocardiography for Insertion of Central Veins Dialysis Catheters

Mean P-wave height via the blue and red catheter lumens

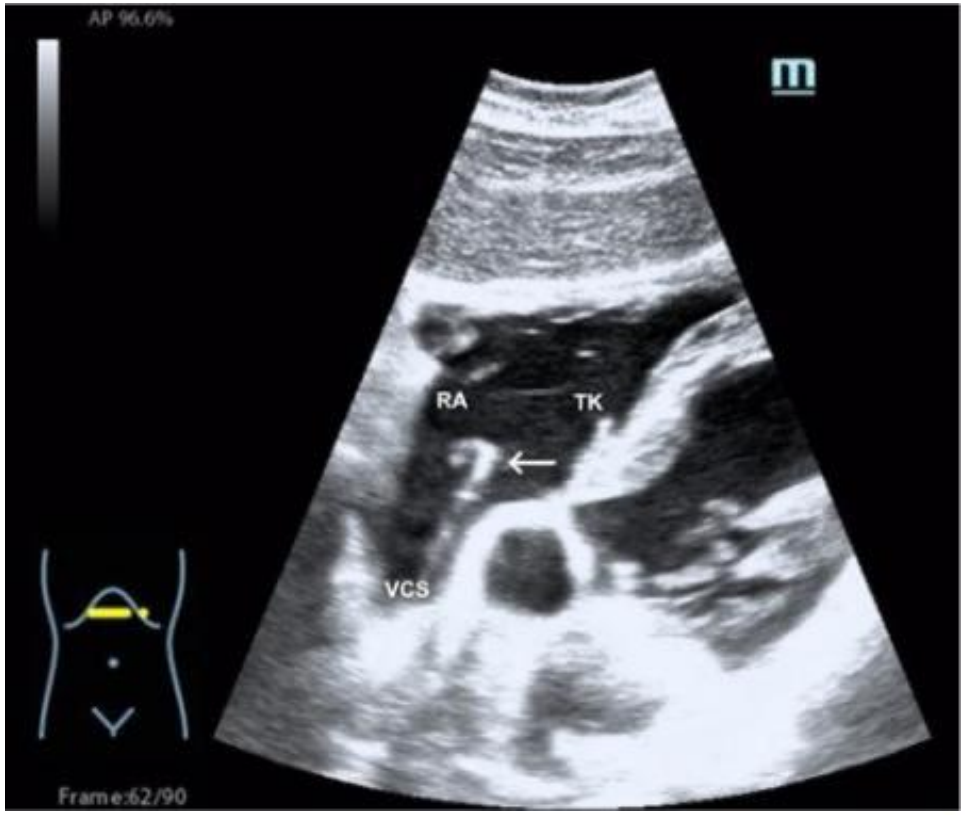


Standard (DII) electrocardiography (above), intravenous electrocardiography through red line (middle) and blue line (below) of dialysis access

1. Beigi AA. Application of Intravenous Electrocardiography for Insertion of Central Veins Dialysis Catheters. Saudi J Kidney Dis Transpl 2009;20(5):794-797
2. Calabria M. Use of ECG-EC in the positioning of central venous catheters. G Ital Nefrol. 2012 Jan-Feb;29(1):49-57

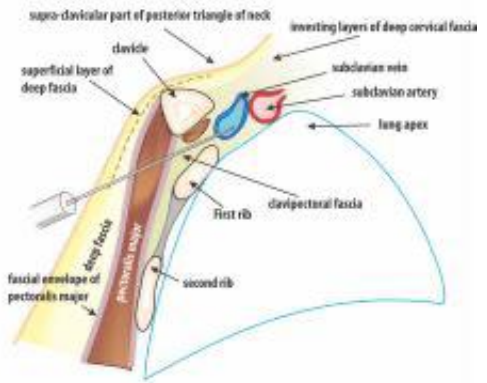
Safety of bedside left sided tunneled dialysis catheter placement

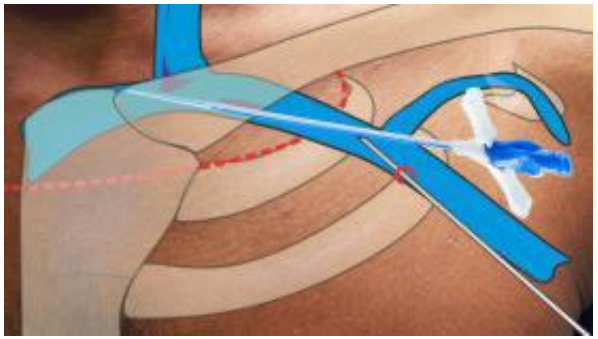
- Small bore catheter
- ECG guidance
- Guide wire exchange
- insert guidewire to visualize with US the position of the catheter tip agitated saline
- In the case of inadequate visibility: intracardiac ECG recording or agitated saline
- safe alternative to fluoroscopy-assisted placement



Kächele M et al. FEASIBILITY ANALYSIS OF AN ULTRASOUND-GUIDED PLACEMENT OF TUNNELED HEMODIALYSIS CATHETERS. Nephrology, dialysis, transplantation, 06/2023

Problems to overcoming





CICC LT
left internal
jugular vein

compressive
hematoma
may require
intubation

haemothorax
pneumothorax

CICC LT
axillary vein
(each side)

pinch off syndrome

stenosis

preclude
shunt
creation

Difficulty advancing
peel-away sheath
or catheter through
sheath

lower

BMI

higher

risk of great
vessel
laceration

thrombosis

FICC LT
left femoral vein

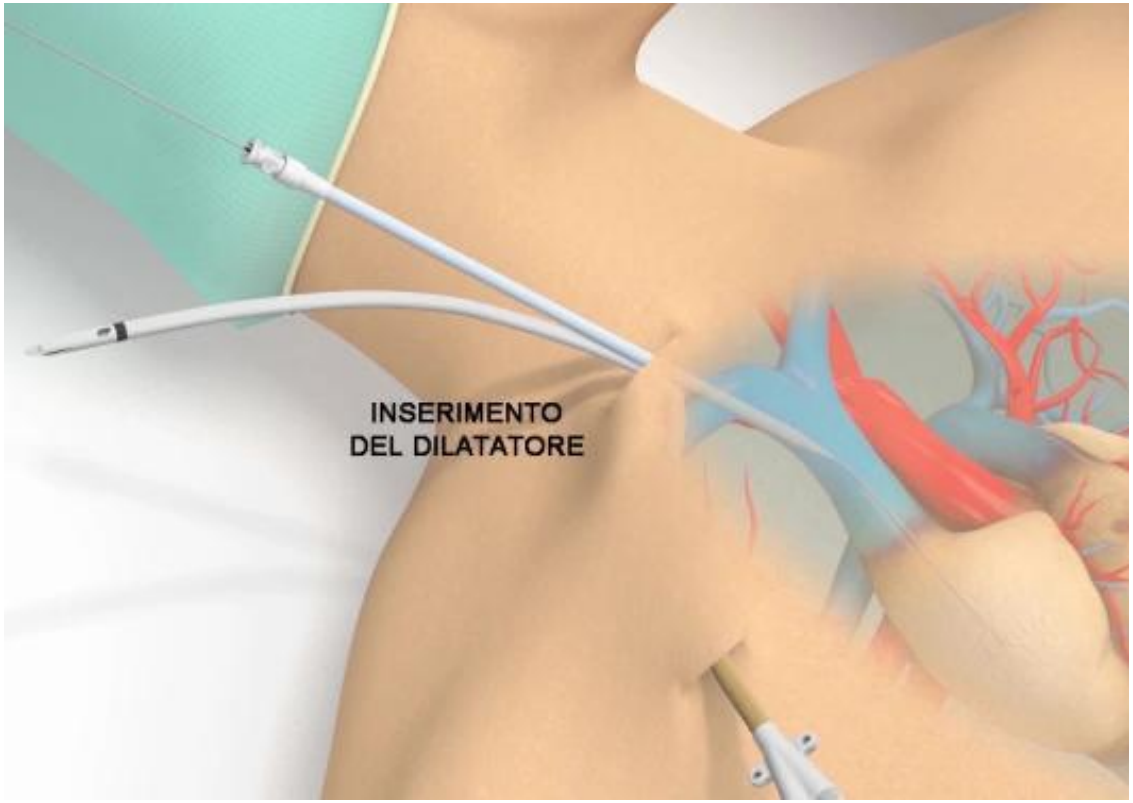
retroperitoneal
haemorrhage

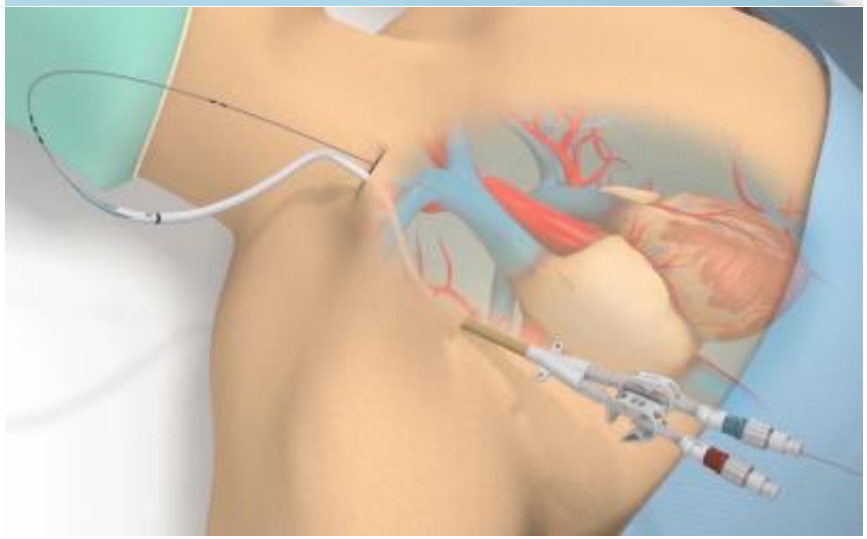
discomfort

Sirvent AE, Enriquez R, Millan I, et al. Severe hemorrhage because of delayed iliac vein rupture after dialysis catheter placement: is it preventable? Hemodial Int. 2012;16(2): 315-319.

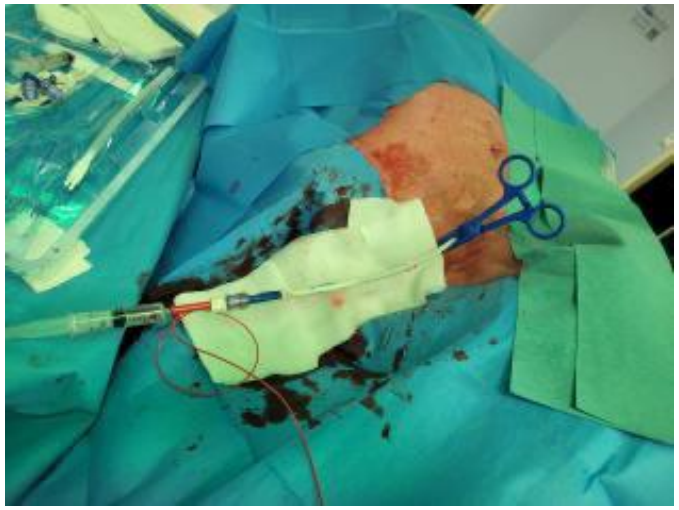
Placement of chronic tunneled hemodialysis catheters over a wire

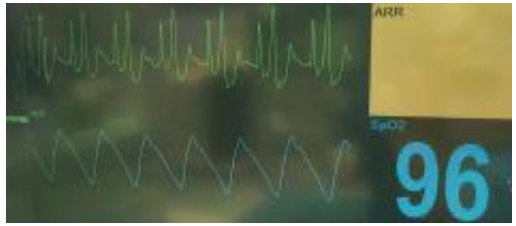
Anterograde tunnelling from the exit site to the vein entry site. Reduced risk of air embolism and blood loss

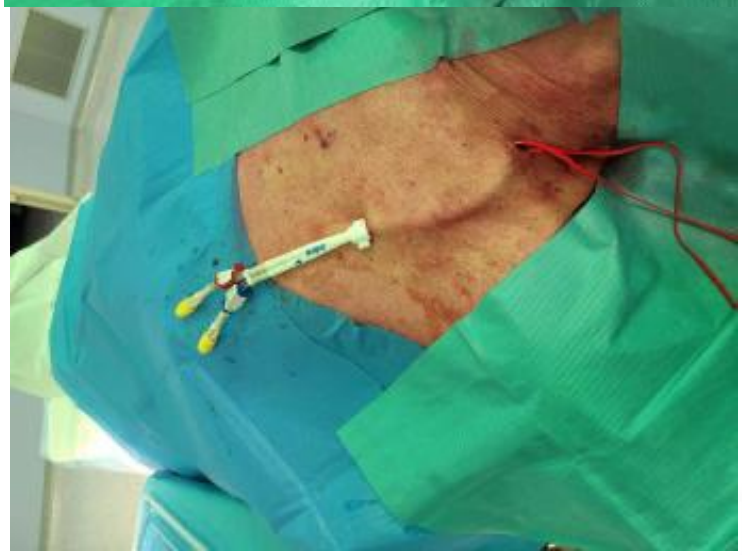




Long Term Cuffed Dialysis Catheters (Tc-CICC LT) with retrograde tunnelling and electrocardiographic guidance



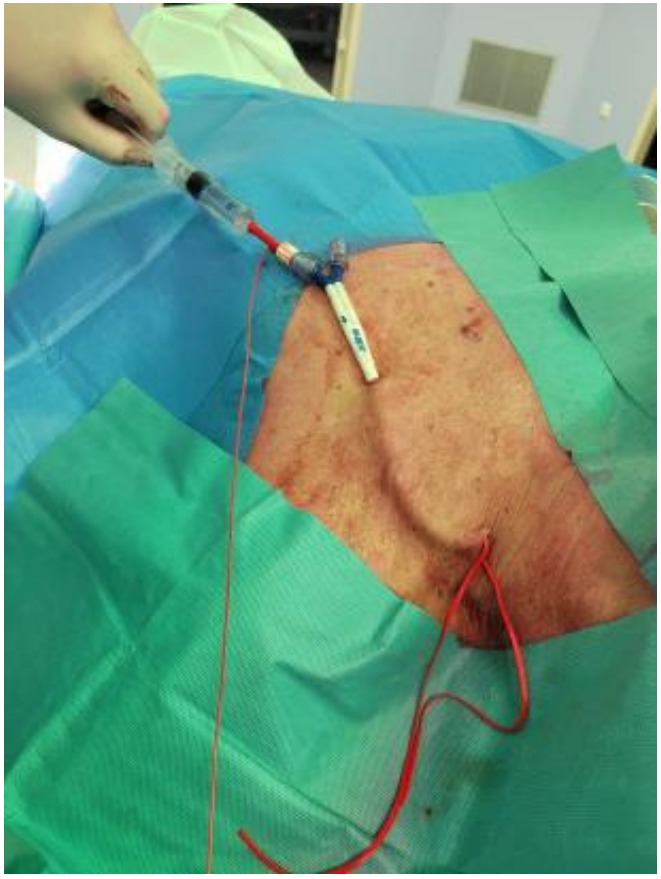




- Venous cannulation with small bore catheter and tip location with ecg
- Kink resistant Nitinol guidewire centimetred to get close to the biphasic
- Stylet to support insertion
- Over The Wire retrograde implantation
- Kink resistant Nitinol guidewire
- PASV Valve Technology
- Valved Peel-Away Introducer

Subcutaneous tunnelling only after tip location

After insertion: evaluation of catheter function and the exact positioning of the catheter tip in the right atrium

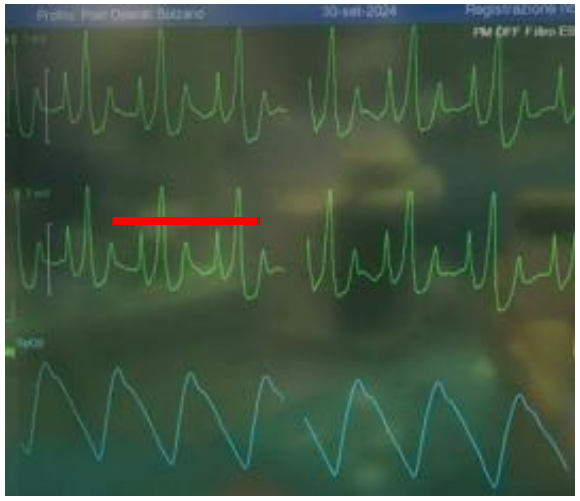


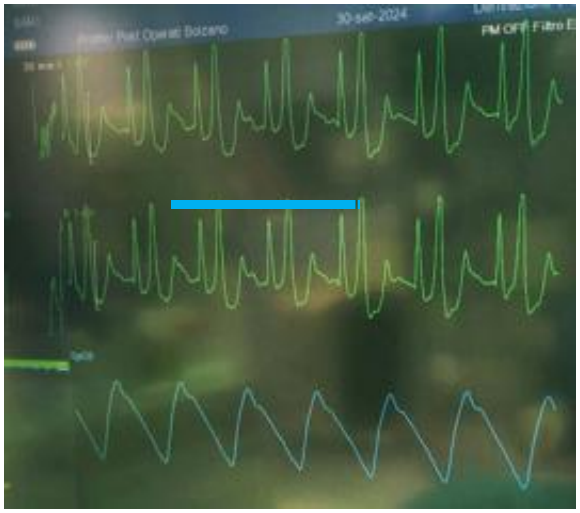
Three **T test**

Check the **Tip** to ensure that it is in the right atrium

Check the **Top** to ensure that the catheter makes a smooth curve without any kinks that will restrict flow.

The **Tug** test is done to check flow by placing a 10 ml syringe on each of the hubs of the catheter and rapidly withdrawing blood into the syringe.





If any problems are identified, they should be corrected before the patient leaves the procedure room.

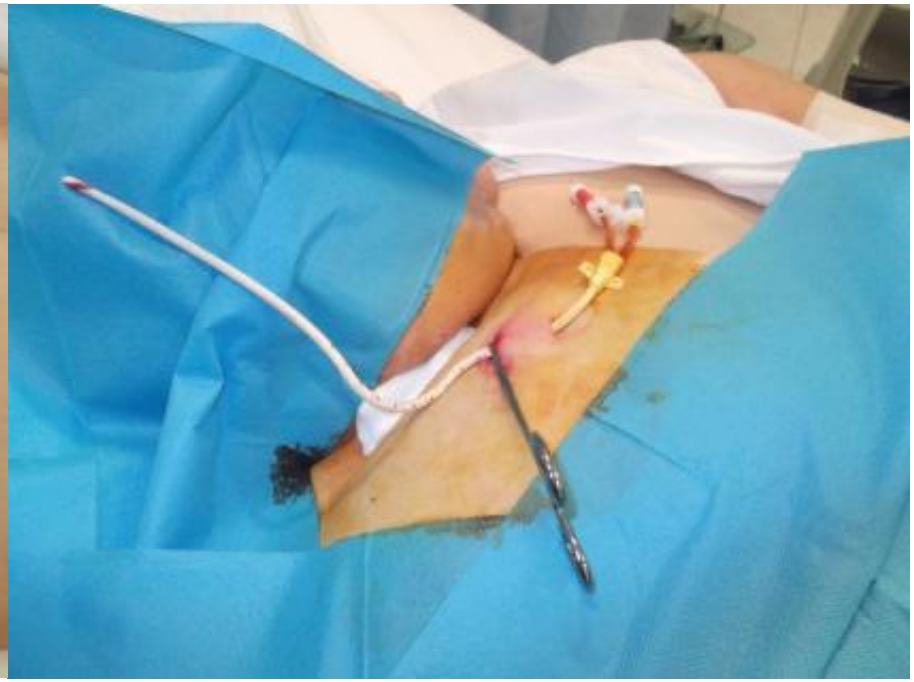
Subcutaneous/adhesive sutureless securement on hemodialysis catheter

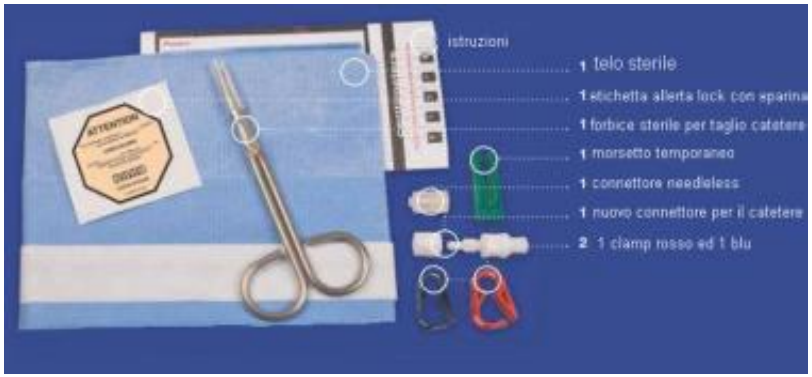
- Not sufficiently large for long-term cuffed dialysis catheters >12 French

- The use of a sutureless securement device is associated with reduced CRBSI risk from hemodialysis catheters
- They do not compromise the skin around the insertion site, unlike sutures
- Cyanoacrylate glue can seal the insertion site

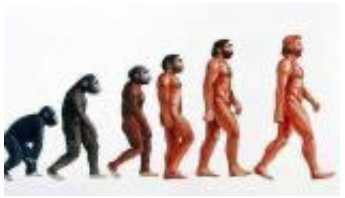
1. Fujimoto K et al. Effect of sutureless securement on hemodialysis catheter-related bloodstream infection. Sci Rep. 2021 Nov 5;11:21771
2. Bahl A et al. Short peripheral intravenous catheter securement with cyanoacrylate glue compared to conventional dressing: a randomized controlled trial. J Vasc Access. 2023;24(1):52-63.
3. Pittiruti M, Annetta MG, Marche B, D'Andrea V, Scoppettuolo G. 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.

Long-Term Hemodialysis Catheter Repair/Removal





The evolution of venous catheterism in dialysis



micropuncture technique with a 21G needle

+

OVER-THE-WIRE INSERTION STYLETS

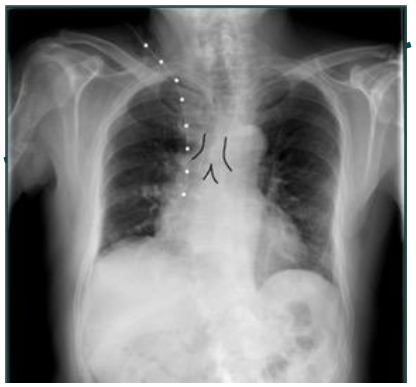
+

Cyanoacrylate adhesives

+

Safety bedside tunneled dialysis placement: ultrasound guided micro puncture approach; contrast-enhanced TTE ; intracavitary ECG navigation

Bedside tunneled dialysis placement: ultrasound and plain radiograph



"Fluoroscopy may not be necessary for cuffed tunneled catheter insertion in selected patients without a history of prior catheters or venous abnormalities"

"Fluoroscopy is mandatory for insertion of all cuffed dialysis catheters" (1)

CVC insertion should be performed in centers where ultrasound guidance and fluoroscopy are available (NKF 2006)

cost savings

1. Schwab S, Besarab A, Beathard G, Brouwer D, Etheredge E, HartiganM, Levine M, McCann R, Sherman R, Trerotola S. NKF-DOQIclinical practice guidelines for vascular access. Am J Kidney Dis 37(supp 11): S169, 2000