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Tunneled Hemodialysis Catheter Insertion: Technical and Clinical Considerations

Julian Yaxley[1,2,3]

[1] Department of Nephrology, Cairns Hospital, Cairns, Queensland, Australia
[2] John Flynn Private Hospital, Tugun, Queensland, Australia
[3] Department of Nephrology, Gold Coast University Hospital, Southport, Queensland, Australia

Address for correspondence Julian Yaxley, MBBS, FRACP, Department of Nephrology, Cairns Hospital, Cairns 4870, Queensland, Australia (e-mail: julianyaxley@yahoo.com.au).

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Abstract

Tunneled hemodialysis catheter insertion is a common and important procedure. Clinicians involved in the placement or maintenance of tunneled catheters require an appreciation of their best clinical application. Although comprehensive guidelines are available, many aspects of the published literature on this subject remain uncertain. This primer offers a concise, evidence-based discussion of 10 fundamental, everyday questions with respect to tunneled hemodialysis catheter insertion.

Keywords
- catheter
- dialysis
- interventional
- nephrology
- tunneled

Introduction

Hemodialysis (HD) requires repeatedly functional vascular access and many patients rely on central venous catheters for this purpose. Approximately 65% of the chronic HD population commences therapy via a catheter.[1,2] Tunneled HD catheter (TDC) placement is a common and important procedure and clinicians involved in the insertion or maintenance of TDCs require a working knowledge of their appropriate technical and clinical application. The present evidence-based digest addresses 10 frequently encountered questions or dilemmas regarding the use of TDCs.

Does This Patient Need a TDC or a Non-Tunneled Catheter?

A principal consideration when initiating a patient on HD is the choice between a temporary, non-cuffed, non-tunneled catheter and a cuffed TDC. Tunneled lines are associated with better longer-term outcomes but procedural insertion is more intricate and invasive. Cuffed TDCs are thereby preferred over non-tunneled catheters in patients anticipated to require HD for more than 2 to 3 weeks, unless the situation is emergent and rapid access is necessary. Suitable candidates for a TDC usually have a background of established chronic kidney disease (CKD). Most presentations of acute renal failure without a history of CKD require dialysis for less than 2 weeks and blanket TDC insertion in these cases is unjustified; such patients should usually commence HD via a non-tunneled catheter, which can be upgraded to a TDC when deemed appropriate. However, TDCs may be elected as initial access for patients with acute kidney injury on a case-by-case basis.

Who Should Insert the Catheter?

Any clinician that is adequately qualified and experienced may perform TDC insertion. Properly trained surgeons, radiologists, and nephrologists undertake the procedure with equal safety and effectiveness.[3] A minimum of 10 autonomous TDC insertions is probably an acceptable degree of experience. Skills are honed relatively quickly, evidenced by data showing that operator complication rates decrease after performing approximately four procedures.[4,5]

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Accreditation requirements and the definition of competency vary among specialty colleges. For example, the American Society of Diagnostic and Interventional Nephrology mandates at least 10 de novo TDC placements to gain proficiency,[6] the Royal Australasian College of Physicians recommends a combined 10 to 20 non-tunneled and tunneled catheter insertions,[7] and no expected number of exposures is specified by the Royal Australian and New Zealand College of Radiologists.[8]

Which Entry Site is Best?

All major guidelines recommend the right internal jugular (IJ) vein as the preferred approach for TDC placement. Its advantages include technically straightforward insertion, provision of effective dialysis, and a low rate of complications. The next insertion site is less clear and is patient-specific. In the absence of definitive evidence, any of the left IJ vein or right and left external jugular veins may generally be chosen as a second preference though the left IJ vein is most conventional. Once these alternatives are exhausted, subclavian, femoral, and translumbar approaches can be considered.

Site selection recommendations are based on only level-3 and level-4 evidence. High-quality comparative trials are desperately needed. Because vascular access decisions are multifaceted, complex, and inexact, it is advisable that the interpretation of published guidance and the literature is framed by careful deliberation of patient circumstances and their overall dialysis life plan.

All insertion sites provide equivalent blood flow and solute clearance in real-world settings.[9–16] IJ and subclavian line placements are associated with comparable rates of immediate success and mechanical complications.[16–20] Although right IJ TDCs are associated with the longest catheter survival, available observational literature is difficult to interpret because a patient's first catheter ordinarily lasts longer than any subsequent attempts. A pilot trial of 40 patients randomly allocated to IJ or subclavian TDC placement suggested greater catheter longevity in the subclavian group.[21]

Central vein stenosis (CVS) is a recognized downstream complication of TDC use. CVS is relevant both for its effect on TDC function and on future surgical arteriovenous fistula creation. Although patients with left-sided and subclavian lines are typically cited as having the greatest likelihood of developing CVS, it is prudent to remember that these associations occurred in uncontrolled settings and have not been directly subjected to randomized study. Several cohort studies identified no relationship between access site (jugular versus subclavian and left versus right) and the incidence of CVS after multivariate analysis, adjusting for factors such as total dialysis duration and the number of past TDCs.[14,22,23] It should be noted that randomized trials comparing subcutaneous implantable port insertion via IJ and subclavian vein routes show equal rates of stenotic complications.[24–26] The number of previous catheterizations is potentially better correlated with CVS risk than site selection; the odds of CVS increase by 38% for each subsequent HD catheter placed.[27]

The risk of catheter-related infection is the lowest with subclavian central venous catheters; the incidence of catheter-related bacteremia for subclavian lines is roughly half that of IJ lines.[17,18,28,29] Multiple controlled trials have demonstrated equal rates of infective complications between IJ and femoral catheters, despite the empiric experience of many clinicians suggesting a greater risk of infection with femoral TDCs.[14,17,30,31] Infection data for left-sided versus right-sided catheters are contradictory.

What is the Optimal Catheter Tip Position?

The ideal tip location for an IJ or subclavian vein TDC is the middle of the right atrium, which optimizes blood flow and minimizes vascular trauma. However, a catheter tip positioned at or just inferior to the cavoatrial junction should also be satisfactory. These suggestions are based on expert opinion and laboratory testing with limited supporting clinical evidence. Positioning is deeper than for temporary non-cuffed catheters, for which the tip is best located in the distal superior vena cava or at the cavoatrial junction due to catheter rigidity. Regarding femoral TDCs, tip placement in the inferior vena cava is favored as this provides superior flow than a shorter catheter.

Which Catheter Style or Brand Is Best?

No TDC style or brand is demonstrably superior to another, though there is a paucity of head-to-head clinical trials. Many catheter designs are available on the market with differing configurations, particularly in relation to tip and lumen characteristics. In vitro results for various features, such as a split tip or heparin coating, have so far not translated into altered patient-oriented outcomes. Practitioners should select a TDC product using their best clinical judgment.

Anterograde TDC insertion is the most common method, but retrograde devices intended for placement through reverse tunneling have also been developed. The main theoretic advantage to retrograde placement is precise catheter tip positioning, although in the scant available literature no difference between techniques has been recorded.[32]

How Long Should the Catheter Last?

Censored median TDC survival is generally reported to be around 6 months.[33] Accordingly, centers involved in catheter placement should strive for a similar record. Catheter dysfunction and exit-site soft tissue infection are the most frequent reasons for line failure.[14]

Is Fluoroscopy Required for Insertion?

Fluoroscopy is not mandatory for TDC insertion but is necessary in some circumstances. Its utilization is institution-specific and should be individualized. Several centers successfully reverted to TDC insertion without fluoroscopic guidance during the coronavirus 19 (COVID-19) pandemic owing to resource constraints. Predictive factors for the unsuccessful insertion without fluoroscopy include left-sided procedures, a history of CVS, and a history of previous TDCs. As discussed earlier, the number of previous catheter placements in an individual patient is a powerful predictor of

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CVS; the likelihood of CVS is ~3% after one TDC insertion, 29% after two to three insertions, and 54% after four or more TDC insertions.[34]

Fluoroscopic guidance has been found in observational series to improve immediate procedural success. For example, in a cohort study of 202 consecutive procedures, the likelihood of adequate radiographic positioning and catheter function was 98% with fluoroscopy versus 92% without ($p = 0.03$).[35] However, the advantages of fluoroscopic control do not extend beyond initial line placement. Once a TDC has been adequately inserted, long-term functionality and patency are unchanged regardless of the imaging technique used.[14] Fluoroscopy does not reduce the rate of major complications and is associated with higher costs and longer hospital length-of-stay.[35–37]

The best application of radiologic guidance is a priority area for future research, especially in the era of bedside ultrasound. Ultrasound guidance is an accepted standard of care for IJ vein TDC insertion; its use increases procedural success and reduces complications, particularly carotid puncture.[38] Guidelines unanimously recommend confirmation of TDC tip position with a post-procedure chest radiograph in instances where fluoroscopy is not used (except for femoral access); this reflects a consensus view and is not evidence-based.[39]

The practical steps of TDC insertion are well-described elsewhere.[40]

Is Cardiac Monitoring Required for Insertion?

Cardiac monitoring is recommended for all neck line insertions through an equipoise of risk versus benefit. Its value for this indication has not been formally investigated. Where telemetry is infeasible, sensible monitoring of patient vital signs is warranted. Supraventricular or ventricular arrhythmias complicate 5 to 10% of IJ and the subclavian vein cannulations due to guidewire contact with the myocardium. They are more common in patients with renal impairment than the matched population. Most dysrhythmias are asymptomatic but a ventricular tachyarrhythmia can rarely be fatal.

Do Antithrombotic Medications Need to be Withheld?

The decision to withhold antiplatelet or anticoagulant medication is one of physician judgment. TDC insertion carries a low-moderate risk of bleeding. Thrombocytopenia and concurrent antithrombotic medication use do not appear to raise the risk of serious hemorrhagic events.[40–42] Coagulopathy is a relative contraindication and most antithrombotic drugs should be withheld for elective TDC implantation if clinically appropriate. Aspirin may be continued without disruption. Society guidelines recommend aiming ideally for an international normalized ratio below 1.5 and a platelet count above 50×10^9/L.[40,42,43] TDC insertion may proceed without interrupting therapy if the procedure is urgent.

Is Peri-Procedural Antibiotic Prophylaxis Required?

Intravenous antibiotic prophylaxis before or during TDC insertion is not endorsed. Rigorous trial data indicate that perioperative antibiotic administration does not reduce the likelihood of catheter-related sepsis or bacteremia.[44–47]

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Conflict of Interest
None declared.

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