Dialysis Catheter: "Love–Hate Relationship"

Hemodialysis remains the most frequently used renal replacement modality across the globe. A vascular access needed to provide hemodialysis falls under two main categories – short term and long term. A central venous catheter (CVC) is a short-term vascular access option, whereas an arteriovenous fistula (AVF) or an arteriovenous graft (AVG) is considered a long-term vascular access.

A CVC can be either tunneled or nontunneled and remains a "bridge" access until an AVF or AVG is available to support maintenance hemodialysis. Majority of the incident patients in the United States and several other countries initiate hemodialysis therapy with a CVC, a fact that is not ideal but remains a bitter truth.[1] The relative ease of placement at multiple sites and immediate usability make CVC a preferred access in an emergent situation. On the contrary, an AVF or AVG requires planning and surgical expertise along with time to heal and mature to support therapy, making it unsuitable for immediate use. Despite its advantages, CVC remains a poor long-term vascular access option due to its higher risk of infection, frequent dysfunction leading to inadequate dialysis therapy, and high overall morbidity and mortality compared to AVF or AVG.

A noninfected but dysfunctional CVC is a frequently encountered complication in clinical practice. Two major reasons leading to CVC dysfunction are thrombosis and fibroepithelial sheath formation. The endothelial damage that occurs during the process of CVC insertion with subsequent activation of inflammatory and coagulation cascade leads to the formation of thrombus. The collagenous layer produced by the smooth muscle cells leads to fibroepithelial sheath formation. In addition, improper handling and flushing of the CVC after completion of dialysis session can also lead to the development of intraluminal thrombus.[2]

Central vein thrombosis secondary to CVC often remains asymptomatic. The presence of a catheter can initiate the coagulation cascade leading to the formation of small thrombus around the catheter, which can be identified with ultrasonography of neck veins. As routine ultrasonography is not a standard practice before CVC removal, a true incidence of CVC-related thrombosis remains unknown. Karnik *et al*. reported an incidence of 64% in 64 consecutive ultrasonographic evaluations of internal jugular vein in an Intensive Care Unit.[3]

The development of catheter-induced right atrial thrombus as reported in this issue remains a serious complication with mortality of up to 45%. A dialysis patient with CVC and poor cardiac function often has multiple intravascular leads from a cardiac rhythm device. The resulting crowding from the hardware in the superior vena cava causes endothelial damage, central vein stenosis, and eventually thrombus formation.[4] The thrombus can extend in the right atrium and generally is detected during echocardiography. Besides dialysis CVC, catheter-related right atrial thrombus (CRAT) has been detected with peripherally inserted central catheters and CVCs with subcutaneous ports. The incidence of CRAT is reported to be 8%–13% in oncology patients as compared to 5.4% in the hemodialysis population.[5]

The treatment strategy for CRAT in a dialysis patient poses two distinct challenges – (1) Catheter management. (2) Management of thrombus and its related complications. As outlined in this case report, there are no optimal guidelines to follow, and management is based on the size of thrombus and its adherence to the catheter or atrial wall. The management of CVC in the presence of CRAT is well outlined by the authors of this case report. If a CVC is removed or exchanged after adequate anticoagulation, the tip of the new catheter should be placed in the superior vena cava and not in the mid-right atrium.

The treatment plan for the right atrial thrombus depends on the available resources and size. If anticoagulation alone strategy is implemented, weekly echocardiography to measure the clot size with close monitoring for signs of complications is an absolute must.[6] An attempt to remove the clot using endovascular techniques may be considered where technical skills and resources are available. Surgical thrombectomy needs to be considered when the thrombus is more than 6 cm, especially in the presence of patent foramen ovale, endocarditis, or valvular defects. The risk of serious complications remains high in this group and could be fatal.[7]

The development of fibroepithelial sheath is another common etiology for CVC dysfunction. The catheter lumen fails to provide adequate blood flow resulting in frequent alarming during dialysis therapy. An attempt to rapidly aspirate ("pull") blood through a lumen is ineffective while pushing a bolus of saline is easily achieved without any resistance. A common phenomenon is described by dialysis staff as – "CVC pushes easily but fails to pull with a 10ml syringe." A general knee-jerk approach is to reverse the connections and complete the dialysis session, which should be avoided beyond one treatment session. A reversely connected dysfunctional catheter can lead to higher recirculation rate resulting in inadequate dialysis therapy. The fibroepithelial sheath can be easily disrupted using an 8 mm or 10 mm balloon and replacing the catheter using the same vascular site.[8]

CVC dysfunction from CRAT and fibroepithelial sheath formation are frequently encountered complications dependent on the duration of catheter exposure. Prolonged use of CVC can increase the risk of catheter-related

bloodstream infection, development of central vein stenosis, and loss of valuable sites to create a long-term arteriovenous access. A CVC (tunneled or nontunneled) should always be considered as a "temporary" or "bridge" access that helps tide over the crisis and provides an opportunity to plan for a long-term access.

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Quick Response Code:

Website: www.indianjnephrol.org

DOI: 10.4103/ijn.IJN_157_17

How to cite this article: Vachharajani TJ. Dialysis catheter: "Love–Hate Relationship". Indian J Nephrol 2018;28:185-6.