Images in Medicine: Central Venous Misadventure

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Abstract

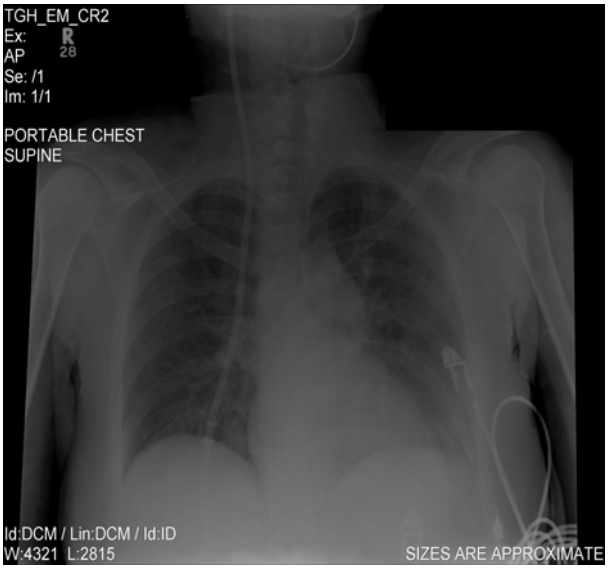
This article reviews the complications associated with central venous catheter placement. The roles of tunneled and not tunneled catheters are described. Periprocedural, thromboembolic, and infectious complications are reviewed.

MeSH Words: Central Venous Catheter, Complications, Infection, Embolic Event

Case

A 43 year old woman presented to the Emergency Department (ED) with a complaint of chest pain.

The woman had a history of autoimmune hemolytic anemia and presented to the ED with a central venous (Hickman) line placed in her right internal jugular vein. The central line was required to assist her with ongoing transfusion requirements. Earlier that day, the central line was dislodged and her spouse had pushed it back in. The chest radiograph demonstrates a mal-positioned central line within the right internal jugular vein, with the catheter tip extending retrograde into the base of the skull.



The poorly positioned central line is also noted on the CT head, though there is no evidence of intracranial hemorrhage or infarction, and the scan is otherwise unremarkable.

The patient required urgent re-positioning of the central venous line and recovered without complications.

Central venous catheters

Central venous catheters (CVCs) are catheters whose distal tips are positioned at the superior vena cava/right atrial junction, the upper right atrium or the inferior vena cava depending upon the inserting physician preference and catheter insertion site. CVCs are essential clinical tools when peripheral IV access is undesirable due to concerns with accuracy of monitoring, safety and access [7]. In such cases, CVCs are required to effectively administer medications, intravenous fluids and parenteral nutrition; perform hemodialysis and hemodynamic monitoring; and draw blood [1,5].

In recent years, the use of CVCs has rapidly expanded from the domain of intensive care units, where they were managed exclusively by specially-trained nurses, to the patient's home, where they are now managed by homecare nurses, family members or patients [2,3].

Given the increasing use and management of CVCs in the community, Emergency Physicians (EPs) need to be aware of the different types of tunneled catheters used in CVCs, as well as the complications that may arise from their use.

Tunneled CVCs

Tunneled CVCs are used primarily for long-term vascular access [3] and are thus the types of CVCs that will most typically be seen by EPs in patients presenting from the community.

(Non-tunneled catheters are typically used for temporary, hospital access and are not the subject of this article.)

Tunneled CVCs are used primarily in hemodialysis patients, though any condition that requires long-term or frequent delivery of parenteral medications, nutrition or blood, requires placement of a tunneled CVC [4].

The most common sites of tunneled CVC insertion are the internal jugular vein, the subclavian vein and the femoral vein [7].

Tunneled CVCs are characterized as large bore catheters (6-14 French.) with cuffs, and require the formation of a subcutaneous tunnel through which the CVC is placed [3]. The cuff is made of Dacron, which allows the surrounding tissue to grow in. Together, the cuff and the tunnel stabilize the catheter and prevent infection [5].

Several brands of tunneled CVCs exist and all may be encountered in Emergency Departments (EDs) to varying degrees. The Hickman catheter is the most commonly used, though the Broviac, Groshong, Neostar and Circle C catheters are all available, with the Neostar offering a triple lumen and the Circle C offering a double lumen. The different brands of tunneled CVCs differ primarily with respect to the type and amount of flushing solution required, the frequency with which the catheter needs to be flushed, and availability of logistical support from the manufacturer (see Table 1). [6]

CVCs placed for hemodialysis are usually more robust (12-14F) to accommodate high flow rates. Those placed in non-dialysis patients are usually of a smaller diameter (6-12F).

Complications of tunneled CVCs

Three major categories of complications exist with the use of tunneled CVCs: periprocedural, infectious and thromboembolic.

Table 1: Comparison of Tunneled Catheter Types

Catheter Type	Flush Solutions	Flush Amounts	Freq. of Flush	Freq. of Dressing Change*	Vacutainer	Syringe Size	Removed By	Repair Kits Available
Hickman	0.9% NaCl 100u/ml Heparin	10ml 3ml	Daily	Every 7 days	Yes	Any	Interventional Radiologist	Yes
Broviac	0.9% NaCl 100u/ml Heparin	10ml 3ml	Daily	Every 7 days	Yes	Any	Interventional Radiologist	Yes
Groshong	0.9% NaCl	10ml 3ml	Weekly	Every 7 days	Yes	Any	Interventional Radiologist	Yes
Neostar (triple lumen)	0.9% NaCl 100u/ml Heparin	10ml 3ml	Daily	Every 7 days	Yes	Any	Interventional Radiologist	No
Circle C (double lumen) **	0.9% NaCl 100u/ml Heparin	10ml 3ml	Daily	Every 7 days	Yes	Any	Interventional Radiologist	No

*For a transparent dressing; all gauze dressings are changed daily.
**For Pediatric patients - Heparin 100u/ml 3ml, 0.9% NaCl 5ml

Periprocedural complications

Periprocedural complications of tunneled CVCs are most critical because of their capacity for immediate life-threatening effects [1].

The most common periprocedural complications associated with tunneled CVCs include arterial puncture, pneumothorax, air embolism and hematoma [7]. The risks of each of these complications differs depending on the site of CVC insertion and on whether imaging guidance was used.

Subclavian catheterization is most likely to lead to pneumothorax, while internal jugular and femoral catheterization are most likely to lead to arterial puncture. Hematomas are much more common in femoral catheterization. [8,9,10,11,12,13]

Overall risk for periprocedural complications is similar in internal jugular and subclavian catheterization (6-12%) – both lower than in femoral catheterization (13-19%) [7].

Infectious complications

Infections related to tunneled CVCs may arise via a number of mechanisms, including exit site infection that leads to pathogen migration along the external catheter surface; intraluminal catheter colonization via catheter hub contamination; and hematogenous seeding of the catheter [7].

Tunneled CVC infections are most commonly due to *Staph. epidermidis* (25%-54%), *Staph. Aureus* (20%), *Candida* spp. (6%) and *Pseudomonas* spp. (6%). Empirical antibiotics are generally directed at Gram-positive organisms. [18]

Recent studies have indicated that subclavian catheterization is associated with a lower rate of total infection than both femoral and internal

jugular catheterization [8,14,15,16].

Thromboembolic complications

Patients with tunneled CVCs are at increased risk for CVC-related thrombosis. One recent study states that up to 5% of patients with tunneled CVCs in intensive care units have thromboses as detected by color Doppler imaging [7]. Though no consensus exists regarding the clinical significance of these thromboses, it is well-recognized that all thromboses have the potential to embolize.

The site of tunneled CVC insertion has a great impact on the risk of thrombosis. One recent study has shown that femoral catherization carries a 21.5% risk of thromobosis, while subclavian catherization carries only a 1.9% risk [8]. Another study has shown that the risk of thrombosis with internal jugular catherization is approximately 4 times that of subclavian catheterization [17]. Based on these studies, it appears that subclavian catherization carries the lowest risk of thrombosis.

Conclusion

Due to the increased use of tunneled CVCs in the community, EPs can expect to encounter increasing numbers of patients presenting to the ED with tunneled CVCs.

The most common sites for tunneled central venous catheterization are the internal jugular, subclavian and femoral veins.

Common complications with tunneled CVCs fall in the categories of: periprocedural, infectious and thromboembolic. It is important in the case of any patient with a tunneled CVC presenting to the ED to have these serious complications ruled out or managed before discharge. As always, the EP must be guided by the patient's signs and symptoms when deciding how to proceed.

In the present case study, the patient was fortunate not to have encountered any serious complications.

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