

CLINICAL STUDY

Complications of central venous cathetrization in hemodialysis patients

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Abstract

When an acute hemodialysis in a patient with no arterio-venous shunt is needed, placement of a central venous catheter (CVC) is the ultimate solution. Otherwise a simple procedure may present with numerous complications.

The authors describe their experiences with early and late complications of CVC in 106 patients. Complications occurred in 20 patients out of 106, a trend comparable or better than previously published by various authors.

The most frequent (16 cases) complication was a catheter-related sepsis. All patients recovered, however in two patients a replacement of CVC was necessary due to the failure of antibiotic treatment. The authors describe the possibility of maintaining the CVC in situ longer than the recommended 1–2 weeks period without more frequent complications. This finding may result from an excellent service provided by the dialysis nurses and from patient education. (Fig. 2, Ref. 22.)

Key words: central venous catheter, complication, sepsis.

When all conservative treatment modalities fail, a hemodialysis is indicated in patients in renal insufficiency. For the hemodialysis purposes we need to secure a vascular access with a flow of 200 ml/min at least.

Temporary vascular access attained by percutaneous central venous puncture (v. jugularis interna, v. subclavia, v. femoralis) serves for a few weeks only. Teflon, polyurethane or silicon catheters with an internal diameter of 1.5–1.8 mm are used. Most of these materials are x-ray contrast (Kováč, 1993).

Permanent vascular access is secured by surgically constructed AV shunts (fistulae) (Fig. 1).

Complications of central venous cannulation

Central venous cannulation, like any other invasive procedure has potential complications. In essence, complications are characterized as early or late. **Early complications.** Central venous cannulation (internal jugular vein and subclavian vein) may present with inadvertent arterial puncture, pneumothorax, hemothorax, superior vena cava or even heart chamber perforation. Less commonly, cases of catheter or guidewire kinking, cardiac tamponade and air embolism have been described (Kováč,

1993; Badge et al, 2003; Silver et al, 1997; Yilmazler et al, 1997; James et al, 1979). These complications occur in 0.1–9.9 % of cases depending on the group monitored, experience, and dexterity of the operator (Braunwald, 1968; Sznajder et al, 1986). The most common simple complications of central venous catheter insertion are arrhythmias. Mostly they are supraventricular extrasystoles, whereas ventricular extrasystoles occur less frequently. Arrhythmias occur more frequently using plain than calibrated guidewires inserted into a depth of 20 cm; more often in individuals shorter than 170 cm than in taller subjects; more often in females than in males.

In none of the cases there was a fatal event (Lee et al, 1996). Evidence shows that the number of complications or successful cannulations vary depending on the chosen insertion site (Malik, 2001).

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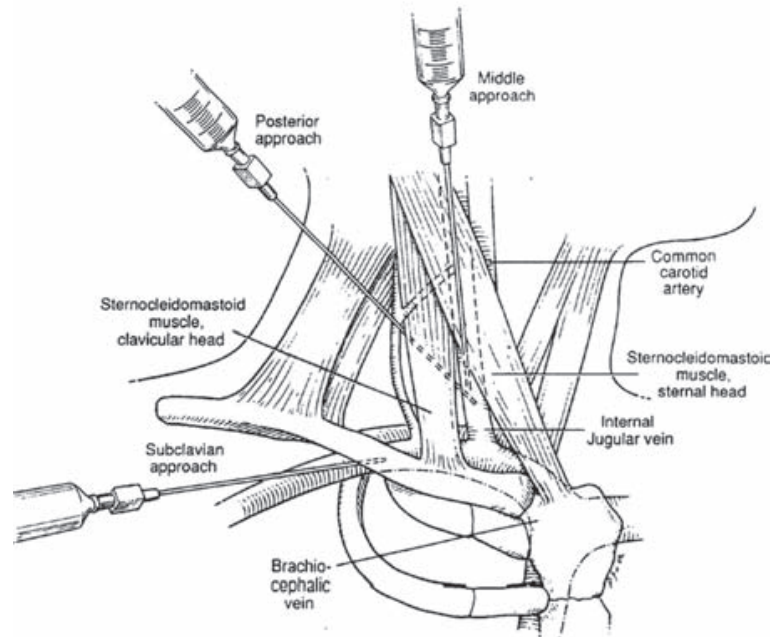


Fig. 1. Topographic relations and most commonly used central venous cannulation techniques (Gonzales et al.1991)

Late complications

Secondary infection is undoubtedly the mostly dreaded event of all complications. It may manifest as local erythema or even septic shock. The most common pathogens are *Staphylococcus aureus* and *Streptococcus epidermidis* (Kukučková et al, 1995; Kováč, 1993). Gram negative microbes such as *E.coli* can cause serious clinical deterioration in the immunocompromised patients.

Other possible late complications are intracatheter blood clot, thrombosis and cannulated vein stricture (Kováč, 1993; Doireau et al, 1993). Serious complication is an infected thrombus situated at the distal end of the catheter or on a wound site of the vessel wall or within the right heart (Doireau et al, 1993; Sasvary et al, 1996; Muckart et al, 1998).

The incidence of these late complications varies from 1 % to 40–50 % (!) apparently due to the stricture of the subclavian vein when leaving the central catheter in situ longer than 2–3 weeks (Kováč, 1993; Mickley, 2002).

Patients

In the years 1998 to 2003, three doctors in our center inserted 106 central venous catheters in 92 patients requiring dialysis. In 2 patients, the indication was resistant cardiac insufficiency, in one case hepatorenal syndrome, in another case acute renal failure; in the rest of the patients the indication was either acutely decompensated chronic renal insufficiency or unfunctional or unprepared artificial a-v fistula.

The group consisted of 47 female and 45 males aged 21 to 85 years (median 66 years). The criteria for central venous can-

nulation were written informed patient consent and of criteria for acute hemodialysis.

Results

Complications of central venous cathetrization

We confronted acute complications in 9 cases (8.5 %). There were 6 cases of unsuccessful central venous puncture at chosen insertion site and three cases of incidental arterial puncture. In none of these cases a serious bleeding had occurred, including significant hematomas or hemothorax even after subclavian artery puncture.

Post-cannulation course was complicated in 20 cases (19 %) (Fig. 2). In one patient we observed an upper limb oedema which resolved after catheter removal. In one case we observed changes on the upper limb imitating axillary vein thrombosis, however there was no sonographic evidence of thrombosis. The internal diameter of the vein had led to a conclusion that a catheter obturation was present. After removal of the catheter we cannulated the contralateral vein. 48 hours post procedure the upper limb oedema resolved, the skin colour returned to normal. The patient had no complaints afterwards. We were forced to replace the catheter in one patient. This was due to venous line thrombosis refractory to dissolution using streptase and failed attempts to resolve luminal patency using guidewire.

In one case we observed a partial luxation of the central venous catheter. The patient had a central line inserted via the left subclavian vein, which was fixed with two skin stitches. We noticed a gradual sliding of the catheter from the central vein, its distal end adhered to the wall of the superior vena cava or the

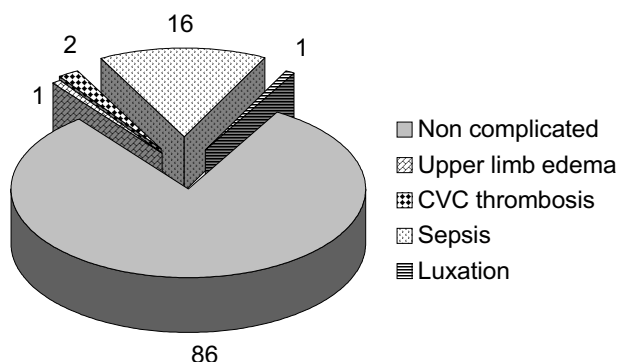


Fig. 2. CVC complications.

right brachiocephalic vein. Hemodialysis was not possible, hence we had to replace the cannula.

In 16 cases we had to admit the patients due to sepsis of unknown origin, which we classified as possible catheter-related sepsis (catheter-related blood-stream infection). We promptly administered 3rd generation cephalosporins (empirically) and collected blood for haemocultivation. Next treatment was tailored to sensitivity. In all patients we documented clinical recovery after the antibiotic regimen, so none of the catheters was removed.

Discussion

The generally recommended time interval for catheters to remain in situ is 1–2 weeks (Mickley, 2002). This is due to a higher risk of infection when leaving catheters indwelling for longer period. We had left catheters indwelling for 1–458 days (median 65, average 76 days). According to our experience, the number of complications caused by infection (16 cases) was not higher than evidence in literature (Unal et al, 2003; Porter et al, 1997; Yilhazlar et al, 1997; Mickley, 2002). The acceptable frequency of these complications together with the low incidence of thromboses requiring catheter replacement (2 cases) point to the right catheter placement technique, excellent catheter service by the personnel at the dialysis center and thorough patient education on living with central venous catheter.

Mechanical restoration of catheter lumen patency using guidewire is a procedure we do not favour knowing the high risk of infection. We tried hard to maintain sterility. Despite our effort we had a case of high temperatures, chills and hypotension after one procedure. The cultivation results (*Staphylococcus aureus*) proved our suspicion and right antibiotic choice. *Staphylococcus aureus* is the most common pathogen observed in other centers as well (Kukučková et al, 1995). We have never observed the most serious Methicillin- and Vancomycin-resistant *Staphylococcus* in our centre.

There is a clear literary emphasis and recommendation that central catheter insertion should be performed by experienced staff, even more cannules for dialysis purposes (larger diameter, longer indwelling period) (Malik, 2001; Gonzales et al, 1991; Uher et al, 2004).

We have slightly modified the subclavian vein cannulation technique described in literature. We have chosen a more lateral approach, thereby avoiding resistance of sternoclavicular scars in the elderly and in individuals with a sharp sternoclavicular joint. Our experience is that guidewire insertion is smoother using this approach demonstrated by Malík, than the lateral infraclavicular approach.

We have never been confronted with vessel wall or cardiac perforation in the patients in whom we accidentally inserted a dilatator or a catheter into an artery. Despite the traditional post procedure AP chest x-ray, this does not guarantee absolute certainty on the position of the catheter (Yoshida, 2003). We presume, that one may minimize the number of “aggressive” complications such as vessel wall or heart chamber perforation by careful guidewire, dilatator and catheter insertion.

We have faced continuous difficulties in some patients during hemodialysis. Heparin-screw and flushing of both central venous links with saline were uneventful. However, when the patients were connected to the dialysis machine we could not reach an adequate blood flow due to insufficient blood supply from the arterial link. After interchanging both links (that is suction through venous link and return via arterial) the problem was solved. This problem occurred mainly in patients with central catheters placed in the left subclavian vein. Our finding does not correspond with other authors (Unal et al, 2003), who report more complications using right sided insertions. We think that the reason is that the cannula inclines against the wall of vena cava or a heart valve.

The treatment of choice for central vein catheter sepsis is the systemic application of antimicrobial agents. We did not remove central catheters at the first signs of fever or sepsis. Instead we indicated application of systemic antibiotics after having sent blood samples for cultivation. If the patient clinically improved within 48 hours of treatment, until we received cultivation results, we left the cannula in situ and continued the treatment regimen for a 21-day period. As all these patients were discharged in good clinical condition, this modality proves to be right.

The discussion whether or not to administer anticoagulation/antiaggregation therapy to patients with central venous catheters to reduce the risk of thrombosis is still not closed. According to the results of the PROTEKT trial (Massicotte et al, 2003), administration of low molecular weight heparin did not reduce the occurrence of thrombosis in these patients. On the other hand, very low doses of Warfarin were successfully used to reduce thrombosis-associated complications (Bern et al, 1990).

This discussion on the complications of central venous lines is not complete since we did not perform angiography after removing the catheters. So we cannot tell whether scar tissues were formed, causing a central vein obliteration.

The central venous catheterization is a safe, feasible and accessible means of securing venous access for hemodialysis. To guarantee the minimal risk of complications during insertion it is necessary that an experienced doctor cannulates the vein. It is recommended that an experienced supervisor is present, if a less

experienced operator perform insertion. In our center we do not have the facility to cannulate central veins under x-ray or USG control, however we have not reported a case of unsuccessful insertion using anatomical landmarks as a guide.

The evidence in literature document that improperly placed catheters and differences in side in the occurrence of malpositioning have not been recorded – apart from one exception of gradual catheter out sliding. Despite missing literary evidence of the advantages of right sided insertions, most central venous catheters are inserted from the right side. The only potential complication a left sided insertion may pose is a possible puncture of ductus thoracicus. This is however rare, it may occur in a patient with liver cirrhosis (Yerdel et al, 1991). We have more experience using left side insertion as guidewire, dilatator and the catheter itself are easier to insert from the left side. This is probably due to the radius of the central vein curvature from the left side compared to the sharp angle of the subclavian vein from the right. We chose the side of central vein cannulation, firstly depending on the side an arterio-venous fistula would be located (we chose the contralateral side), secondary depending on the dominant hand of the patient. We chose the nondominant hand.

Our experience highlight the possibility of leaving central venous catheters in situ longer than the generally recommended 1–2 weeks, thanks to the excellent service provided by personnel and the through patient education on daily care.

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