

Review Article

Peripherally inserted central catheters and midline catheters in artificial nutrition. Indications and limits

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ABSTRACT: *The choice of the venous access for parenteral nutrition involves several considerations: clinical issues of the patient, timing and estimated duration of the nutritional support, osmolarity of the parenteral solution, availability of peripheral veins, patient's personal preference and comfort and the preferences of the nutrition team. In recent times, a growing interest has been focused on the use of midline catheters and peripherally inserted central catheters (PICCs): these are medium-term venous devices, inserted through a peripheral vein, which can be utilized either as central (PICC) or peripheral (midline) catheters. Their use is increasing worldwide, both for hospitalized patients and for outpatients in day hospitals, hospices, or at home. The Centers for Disease Control and Prevention in Atlanta, USA, in the last edition of their "Guidelines for the prevention of intravascular catheter-related infections," recommend the use of PICCs or midline catheters whenever the risk for catheter-related bacteremia is high. The adoption of these devices, according to their specific indication, should allow us to optimize the management of infusion therapies, reducing the number of peripheral venous accesses for each patient, the risk of infection and of venous thrombosis (Nutritional Therapy & Metabolism 2006; 24: 164-7)*

KEY WORDS: *Parenteral Nutritional, Central Venous Catheter, PICC catheters, Midline catheters*

INTRODUCTION

Parenteral nutrition (PN) is usually administered by the delivery of nutrients through peripheral or central venous lines. When choosing the appropriate venous access, one should take into account several issues, such as the estimated duration of the parenteral nutrition, the clinical and psychological characteristics of the patient, the individual experience and preference of the nutrition team, the expected osmolarity of the PN solution, the degree of availability of peripheral veins, the technical feasibility of jugular, subclavian or femoral venipuncture, as well as the setting of the PN administration (hospital, home or hospice).

Until recent years, PN in the adult patient was administered choosing one of these routes:

a) short-term peripheral line: a short (35-52 mm) Teflon cannula inserted in a peripheral vein of the arm (mainly basilic or cephalic veins or their collaterals);

b) short-term central line: cannulation of a "central" vein (subclavian, internal jugular or femoral) with polyurethane catheters (15-30 cm long), positioning the tip in the superior vena cava, in the right atrium or in the upper part of the inferior vena cava;

c) long-term central line: cannulation of a central vein with a silicone or polyurethane catheter, positioning the tip in the superior vena cava, in the right atrium or in the upper part of the inferior vena cava; in these devices, long-term stability and protection from skin contamination are assured by tunneling the catheter or by connecting it to a reservoir positioned in a subcutaneous pocket.

Short-term peripheral lines allow the infusion only of iso- or hypo-osmolar solutions, while short-term and long-term central lines can be used also for hyperosmolar solutions. Furthermore, short-term lines (peripheral and central) are used mainly for hospital PN, while long-term central lines, with their particular characteris-

tics of high stability and duration, are suitable for home parenteral nutrition (HPN).

In this context, the use of peripherally inserted central catheters (PICCs) and midline catheters – usually classified as medium, term venous lines – is becoming more and more widespread worldwide, both in hospital and for outpatient PN (day hospital, hospice and HPN). Both midline catheters and PICCs require cannulation (either “blind” or ultrasound-guided) of either the basilic vein, brachial veins, cephalic vein or their collaterals. Their most important advantage is to ensure a stable venous line, whether peripheral (midline) or central (PICC), for weeks and even months, without the risk of immediate complications specific to central line positioning (pneumothorax, hematomas and arterial lesions). Another important advantage is the reduced risk of septic events (catheter-related blood stream infections) that represent the most common cause of morbidity and mortality for patients with short-term central venous lines. In fact, the Centers for the Disease Control and Prevention (CDC) in Atlanta, USA, strongly recommend, in their latest edition of “Guidelines for the prevention of intravascular catheter-related infections” (1), the use of PICCs and midline catheters in cases with an expected necessity of PN longer than 6 days (recommendation strength 1B).

PERIPHERALLY INSERTED CENTRAL CATHETERS

Peripherally inserted central catheters (PICCs) are non-tunneled mid-term venous devices that are inserted through peripheral veins, and designed for infusion therapies that may last from 1 to 6 months. They are made of silicone or of third-generation polyurethanes, which have high biocompatibility and minimal thrombogenicity. Their caliber is quite small (ranging from 3 to 6 French for adult patients, but as small as 1F-2F for neonates), their length is 40-60 cm and the tip can be either closed (with a Groshong valve) or open. Some of them (if 5F or more) are available with a double lumen. Their insertion is performed either by the so-called blind technique (aiming toward visible or palpable peripheral veins of the antecubital groove of the arm), or by ultrasound-guided puncture and cannulation of deeper veins of the midarm (basilic vein or brachial veins). Their distal extremity should reach the inferior third of the superior vena cava or the upper third of the right atrium.

The main indication for a PICC is the necessity of a medium-term infusion (1-3 months) of PN, chemotherapy or other solutions requiring a central line (that is >500 mOsm/L solutions, solutions with pH <5 or >9 or

irritating drugs that would damage the intimal layer) (2). In this setting, a PICC should be regarded as a central, stable venous line that will avoid repeated cannulation of the peripheral veins, and that can be inserted (by the ultrasound technique) even in patients with very poor or absent superficial veins of the arm. Furthermore, PICCs are ideally indicated in patients requiring a central line, but with absolute or relative contraindications to central insertions (foreseen technical difficulties, coagulopathies etc.). An additional advantage is the possibility to insert a central venous line in a hospice or at home, especially because the insertion procedure is simple and harmless, and it can be performed by adequately trained nurses or by physicians who are neither surgeons or anesthesiologists. Finally, the risk of catheter-related blood stream infection is significantly lower compared with short-term central venous catheters inserted in the jugular or in the subclavian vein (6).

The wide range of indications for PICCs includes any kind of outpatient requiring i.v. therapy for weeks or months (cancer patients, patients with chronic infections such as osteomyelitis or endocarditis, immunosuppressed or HIV patients, hospice or home-assisted patients with an expected duration of life less than 3 months), as well as hospitalized patients requiring a central line for a prolonged period (3). As already noted, every type of solution (even hyperosmolar) can be administered through a PICC, due to the central positioning of the tip.

Specific contraindications to PICC use are rare and may derive from peculiar anatomy or pathologic abnormalities of the arm (severe damage due to previous deep thrombophlebitis, previous or future radiation therapies on the insertion site etc.). The absence of superficial veins is not a contraindication to PICC positioning, since ultrasound guidance almost always allows identification and cannulation of the deep veins of the midarm. On the other hand, a relevant contraindication is the need to give high flow infusions (>200 ml/h, especially with high viscosity solutions such as lipid emulsions): the low diameter (2F-6F) and great length (40-55 cm) of the PICC make it highly resistant to the passage of fluids.

Open questions remain regarding potential complications – infectious or not: local phlebitis and thrombophlebitis, sepsis, migration of the catheter’s extremity, rupture and embolization after PICC positioning. Allen and colleagues conducted a study on a series of 137 PICCs and documented the direct correlation of vascular thromboses with the number of repeated attempts to position the device. Furthermore, this study showed an increased rate of complications with the cephalic vein, compared with the basilica vein (7).

An important issue is the most appropriate diameter

of the PICC. Grove and colleagues studied 678 patients with 813 PICCs inserted and found that the incidence of thrombosis was not influenced by the operator who positioned the catheter (radiologists had 3.7% of thromboses while nurses 4.5%), but by the diameter of the catheter (0% of thromboses with 3F, 6% with 5F and 9.8% with 6F) (8). Ultrasound-guided insertion at midarm appear to be associated with a lower risk of thrombosis compared with blind insertion at the antecubital fossa.

Spontaneous migration of the extremity ("tip migration") has been described as a frequent issue (58% of cases in some series): the dislocation is 20 mm on average, more caudal than cranial, and is significantly correlated with patient's arm movements (abduction or adduction) (9).

A review of the clinical experiences and the series published in the literature suggest a list of the most reliable strategies to reduce such complications:

- low diameter PICCs (3F-4F) should be preferred;
- the PICC should be inserted in the dominant arm (or in the arm most likely to be mobilized);
- the cephalic vein should be avoided, if possible;
- the catheter should be inserted in the largest vein available, possibly at midarm, at least 1-2 cm proximal to the antecubital fossa;
- ultrasound positioning, when available, should be preferred to blind positioning.

The systematic use of these guidelines would reduce infectious and thrombotic complications as well as tip migrations. Specific concerns exist for PICC use in PN due to flow resistances (especially with low-diameter catheters and hyperosmolar solutions – i.e., those containing lipids) or the tendency, especially for lipid emulsions, to occlusion of the lumen. These complications can be reduced using the appropriate diameter (4F) and a dedicated continuous infusion device (nutritional pump).

MIDLINE CATHETERS

Midline catheters are nontunneled, "long" peripheral venous catheters initially designed for intravenous therapies to last for 1-6 weeks. They are made of silicone or third-generation polyurethanes; the tip end can be closed (Groshong valve) or open. They are 8-20 cm long and, for this reason, are considered of intermediate length (hence the term "midline") between short peripheral cannulas (3-5 cm) and PICCs (40-60 cm). As with PICCs, their insertion is usually performed either by the blind technique or by ultrasound guidance, in veins at the antecubital groove or at midarm (basilic, brachial,

cephalic or collateral veins). Due to their limited length, their tips reach only the axillary or subclavian vein and thus they are not "central" but "peripheral" venous catheters.

The main indication for the use of midline catheters is the need for a short-term or mid-term (weeks) peripheral access for i.v. infusion of hypo- or iso-osmolar PN, blood products, chemotherapy, antibiotics or any kind of non-vesicant solution with pH >5 and <9. Midline catheters have a wide range of potential uses in any medical or surgical patient with prolonged hospitalization, as well as in any patient where a need for long-term i.v. treatment is a contraindication to a central line insertion. Midline catheters can be used both in hospital and at home.

Their main advantage is to allow the maintenance of a peripheral line for weeks, with a very low risk of local phlebitis (when compared with short peripheral lines) and a very low risk of bloodstream infections (when compared with nontunneled central venous catheters inserted in the jugular, subclavian or femoral veins).

In a study by Goetz and colleagues, 334 midline catheters in 248 patients (median age 65 years) were studied for 2 years, with an incidence of bacteremia and catheter colonization significantly lower than those associated with central venous lines (11). Matsumoto advocated the use of midline catheters for PN longer than 10 days and with osmolarity lower than 500 mOsm/L (10). Other advantages of midline catheters are the easiness of insertion (which does not require post-insertion x-ray), the feasibility of intermittent use, and their low resistance to flow when compared with PICCs (which makes midlines appropriate particularly for blood transfusions, drawing blood samples and high-flow hydration).

The field of application for midline catheters is growing and includes patients hospitalized for a relevant length of time (weeks or months). In the past, venous access was maintained in these patients by repeated cannulations of the peripheral veins with short cannulas (which should be removed every 3-4 days, according to CDC guidelines) (1). The advantage of a stable peripheral venous access that can last weeks is clearly associated with greater comfort for the patient, reduced burden of work for nurses, reduced risk of accidental injury to health operators from sharp implements and thus reduced hospital costs.

As with PICCs, ultrasound positioning of midline catheters lowers the risk of thrombophlebitis and allows positioning of these catheters practically in any patient, even in those with a very poor set of peripheral veins (due to repeated cannulations, long hospitalizations, drug dependence, obesity, diabetes etc.). The only clear

contraindications to a midline catheter are (a) the need to infuse hyperosmolar solutions (>500 mOsm/L), vesicant drugs or solutions with pH <5 or >9 (in this case, a central line is needed); and (b) the need for a long-term home infusion lasting more than 3 months (in such cases, a tunneled central catheter or a port are indicated).

The presence of sepsis or candidemia (which contraindicates the use of a central venous line) does not contraindicate the use of a midline catheter: that is why midline catheters are particularly useful in prolonged i.v. antibiotic treatments prescribed for osteomyelitis, endocarditis or staphylococcal infections.

CONCLUSIONS

According to the current literature, PICCs and midline catheters can be particularly useful in PN, as long as some important prerequisites are satisfied:

- health providers must be aware of the available devices and their correct indications. This will allow them to choose the device according to the clinical characteristics of the patient, the type of planned PN and the duration of treatment;
- PICCs or midline catheters should be positioned by trained personnel; whenever possible, their insertion should be performed with ultrasound guidance, using

the microintroducer technique, so as to avoid local traumas and reduce the risk of thrombosis or infection;

- occlusion of the device with lipids can be prevented by choosing catheters with a diameter of 3F-4F, and by using a nutrition pump.

These measures will give the best performance of these devices and ameliorate the management of infusion therapies both for hospitalized and home patients, reducing the number of venous cannulations for each patient, lowering the risk of infectious or thrombotic complications and limiting the use of short-term central venous lines. Also, PICCs and midline catheters allow prolonged i.v. treatments even in patients with poor or absent peripheral veins as well as in patients with high risk of infection (or who are already septic), where traditional short-term central venous lines are contraindicated.

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