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TECHNICAL INNOVATION

A method to accurately estimate the catheter length needed for a tunneled central catheter placement

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Abstract
A typical method of placing a tunneled central catheter utilizes C-arm fluoroscopy for insertion and estimation of the length of the catheter needed. We describe a new technique to estimate the length more accurately using a C-arm fluoroscope.

Keywords Tunneled central catheter · Fluoroscopy · Catheter length

Introduction

Tunneled central catheters are commonly utilized for long-term central venous access in patients. Specific catheter types include Broviac, Hickman, and port catheters [1]. They may be utilized for chemotherapy, plasmapheresis, hemodialysis, long-term parenteral nutrition, and antimicrobial treatment [2]. A commonly used technique for inserting and measuring the proper length of a tunneled central catheter utilizes C-arm fluoroscopy. We describe a method to accurately estimate the length of the catheter needed using a C-arm fluoroscope; this technique provides an additional tool in the surgeon's armamentarium.

Description of technique

Hickman catheter placement using a subclavian vein approach is illustrated. A standard tunneled central venous catheter kit (Bard Access Systems, Salt Lake City, Utah, USA, http://www.bardaccess.com) is opened on the sterile back table. The catheter is aligned with the J-guidewire in a parallel fashion with the straight end of the J-guidewire next to the cuff of the catheter. The excess length of the catheter is cut, such that the length of the catheter from the cuff onwards exactly matches the length of the J-guidewire (Fig. 1). A standard percutaneous Seldinger approach is used to place the J-guidewire into the subclavian vein and into the right atrium. Once the wire placement is confirmed using the C-arm, the guidewire is pulled or pushed out, such that the tip of the J-guidewire lies at the desired location of the future catheter (Fig. 2).

An incision is made away from the venipuncture site where the catheter will be tunneled. The surgeon than decides where the cuff of the catheter will rest, which is usually just superior to the skin incision. The J-guidewire is overlaid on the skin toward the skin incision. A clamp is then applied on the J-guidewire corresponding to the position where the surgeon would like the cuff to be positioned under the skin. The extra length of the Broviac catheter that should be cut to produce the exact length needed is equal to the wire length from the clamp toward the non-J end of the wire, which is outside the body. The extraneous Broviac catheter is cut by matching the end of the Broviac catheter with that of the wire from the clamp toward the external non-J end (Fig. 3a). Figure 3b illustrates the similar maneuver during a port catheter placement. The remaining Broviac catheter placement is done using a standard peel-away Seldinger technique. After placing the catheter, the final fluoroscopic image of the catheter tip position is obtained (Fig. 4).

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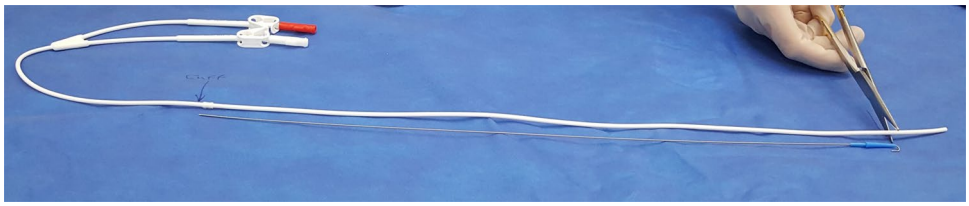


Fig. 1 Hickman catheter is aligned with the J-guidewire in a parallel fashion with the straight end of the J-guidewire matched to the cuff of the catheter. The redundant length of the catheter is cut with a scissors at the corresponding location of the J part of the guidewire

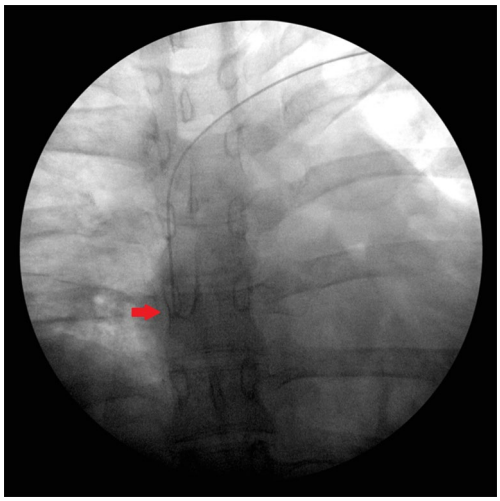
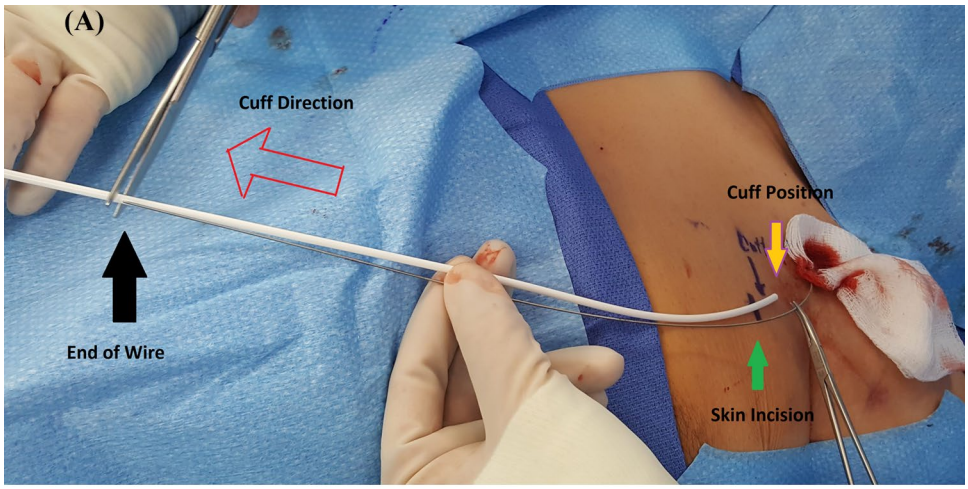


Fig. 2 C-arm fluoroscopy shows the tip of J-guidewire (arrow) positioned at the eventual desired location of the future tunneled central catheter

Discussion

Several methods to ascertain the optimal insertion length of tunneled central venous catheters have been described [3–6]. These methods include utilizing pre-procedure chest X-ray to determine optimal length [4] and choosing a length based on patient height, as validated by retrospective data [5]. While the use of ultrasound has been validated for PICC line placement in infants, X-ray in the form of fluoroscopy remains necessary for tunneled venous catheter placement in infants and children [3]. A method to place the catheter exactly without the radiation exposure to patients and physicians performing the procedure would be ideal. Our technique may reduce the overall radiation exposure by eliminating the guesswork needed to determine catheter length. The usual technique of simply overlaying the catheter and estimating its length with fluoroscopy or using chest land mark such as angle of Louis, second intercostal space, or nipple levels uses two-dimensional topography, which fails to account for the three-dimensional course that the guidewire or the catheter traverses through the subcutaneous tissue. The key step needed to eliminate the guesswork is to make the length of the catheter from the cuff onward and the J-guidewire the same. Depending on the commercial kit used for the catheter placement, the J-guidewire that comes with the kit may be longer than the entire length of the catheter. In this situation, the J-guidewire is cut at the non-J end of the wire with a sterile wire cutter to match the catheter length. The aim is the same in either situation; it is to make the guidewire and the catheter length the same starting from the cuff to the end of the catheter. For port catheters, which are usually made without a cuff, the cuff equivalent for the port catheter is the location where the catheter joins the main body of the port (Fig. 5).

We have performed ten tunneled central catheter placements during the first 2 months of 2018 using the described technique. The technique has been uniformly reproducible and accurate in all ten cases. There are two pitfalls worth describing to prevent procedural difficulties. First, once the J-guidewire has been placed and the extraneous tunneled catheter length has been cut to produce the exact length, it is advisable to push the J-guidewire further into the right



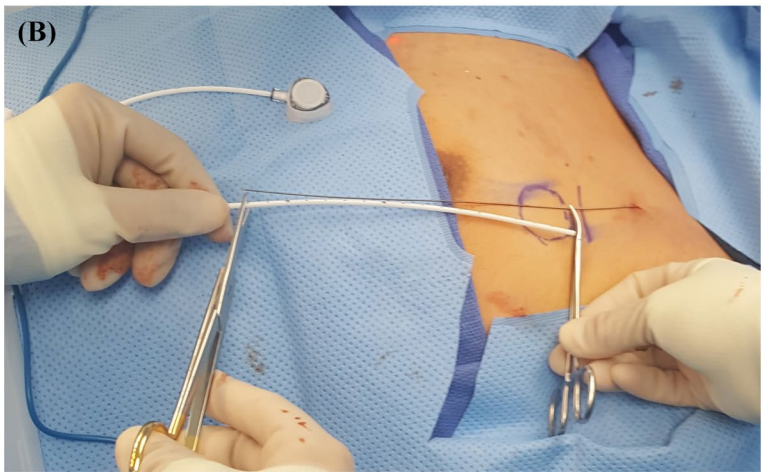


Fig. 3 **a** External portion of the J-guidewire is positioned to mimic the course of the tunneled central catheter toward the incision site. A clamp is applied at the eventual location of the cuff. The length of J-guidewire beyond the clamp is equal to the excess catheter length that needs to be cut. Black up arrow indicates the end of the J-guidewire. Red horizontal arrow shows the direction of the catheter cuff. Green up arrow indicates the skin incision site. Yellow down arrow indicates the intended cuff location. **b** Similar maneuver is done for a port catheter placement

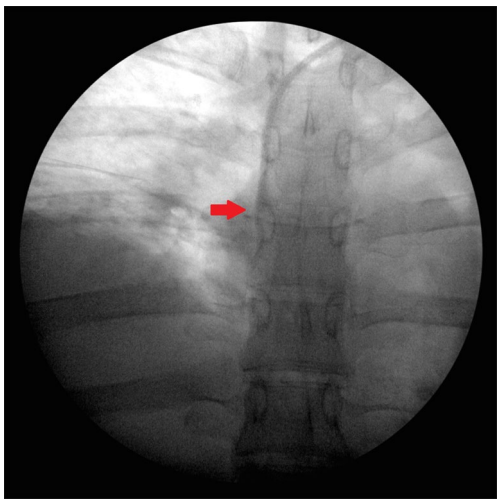


Fig. 4 Final position of the catheter is confirmed using C-arm fluoroscopy. The arrow indicates the tip of the catheter

ventricle, such that there is now extra wire length within the heart. Without the extra guidewire length in the heart, when the peel-away sheath is pushed over the wire, it may be directed toward the subclavian vein instead of the right ventricle. Second, when the guidewire is longer than the catheter, it is better to trim the guidewire with a wire cutter rather than with a heavy scissors to obtain a clean cut, such that peel-away sheath-dilator placement over the wire is easy.

In summary, the use of proposed technique results in accurate catheter length to precisely position the catheter tip within a central vein irrespective of patient size. Adoption of this method should reduce surgeon's frustration of not placing a tunneled central catheter in a desired location.

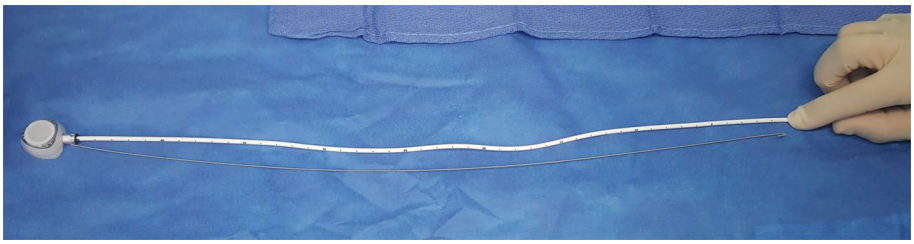


Fig. 5 Port catheter and J-guidewire are placed on a table to show that they are equal length

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Compliance with Ethical Standards

Conflict of interest All the authors (Mihir Chaudhary, Olajire Idowu, and Sunghoon Kim) declare that we have no conflict of interest.

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent Informed consent was obtained from all individual participants included in the study.

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