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Review Article

Clinical Application Analysis of Tunneled-PICC

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Abstract: Peripherally inserted central catheters (PICCs) play a critical role in the infusion of parenteral nutrition, chemotherapy and intravenous fluids for the increased safety and efficacy for long-term use. However, during the insertion and management of PICCs, there are still some PICC-related complications need to be reduced as much as possible for both operators and researchers. In this case, the tunneled-PICC provides a new "a nedesl subcutaneous route" technology for PICC application. This article reviews the principle and characteristics of tunneled-PICC. Tunneled PICCs, seems to be a safe option and easy to perform as an alternative to standard placement for its advantages of the better exit location, reduced incidences of thrombosis and infection, reduced the shift rate as well as extended retention time. However, more research on the standard tunneling technique and large-scale clinical applications need to be proposed.

Keywords: Peripherally Inserted Central Catheters (PICC), Tunneled-PICC, Intracavitary Electrocardiogram (IC-ECG), Ultrasound Guidance

1. Introduction

Peripherally Inserted Central Catheters (PICCs) which can be inserted into central venous veins via peripheral veins, such as the cephalic vein, basilic vein or brachial vein, are usually used in the treatment of medium to long-term intravenous infusion, irritating drugs infusion and intermittent infusion of chemotherapeutic drugs [1-2]. The advantages of safety, convenience, long duration and low infection rate allow the tunneled PICCs get increasing popularity in clinical application [3].

The successful PICC insertion technique has three developments, the anatomical landmark method, the ultrasound technology and the intracavitary electrocardiogram (IC-ECG) method [4]. The anatomical landmark method is the basic skill for PICC placement. The ultrasound technology is well applied recently for the clinical benefits of vein assessment, venipuncture and ruling-out gross malpositions, reducing the PICC associated complications [5, 6]. The intracavitary electrocardiogram (IC-ECG) method has been proved to be safe, accurate and highly cost-effective, because it saves the expenses related to post-procedural X-ray confirmation and possible repositioning of malpositioned catheters [7-9]. Despite the numerous benefits of PICCs, all-cause PICC-related complication rate is 11.77% to 17% [10-12], including infection, pain, bleeding, and mechanical dysfunction, all of which contribute to patient discomfort and additional healthcare costs [13, 14]. The deep vein thrombosis caused by the occupying effect of the catheter in the blood vessel may lead to pulmonary embolism and death, which has become the most closely concerned complication of researchers in the world.

Several studies have shown that anticoagulation/antiplatelet agents didn't prevent the occurrence of deep vein thrombosis, while increased the risk of bleeding and abnormal blood coagulation [13]. Current literature in oncologic populations,

as well as the evidence-based clinical practice guidelines, recommend against the routine use of venous thromboprophylaxis in patients with central venous catheters [16,17]. Therefore, selecting larger blood vessels, optimizing the ratio of vein to catheter diameter, reducing the length of PICC insertion in the blood vessels, and reducing the mechanical friction damage caused by joint movement and muscle exion have become the main points of research.

2. Tunneled PICC Technology

The PICC Zone Insertion Method (ZIM) proposed by Dawson is a systematic approach to PICC insertion for the purpose of results optimization and the reduction in patient risk [18]. It aids in identifying the Ideal Zone (IZ) for upper arm needle insertion with ultrasound guidance. The upper arm (~21cm) can be divided into three 7cm zones to form the Red, Green and Yellow Zones (Figure 1). The yellow zone is the most suitable for PICC puncture for the large blood vessel diameter and flow, but It is not suitable for the exit position of PICC (large body fluid secretion, mechanical friction, etc.); The green zone is the ideal target area for PICC puncture and exit; The red zone is neither suitable for PICC insertion nor exit. The ideal way is to puncture in the yellow zone and lead out from the green zone, eliciting the concept of the tunneled PICC [19]. This technique involves creating a subcutaneous tract after the puncture of the vessel with the aid of a special tunneller. The oral procedure is as follows: assess the green zone, choosing an ideal exit site; assess the yellow zone, choosing an ideal insertion site; the distance between exit site and insertion should not longer than 5cm; then local anaesthetic (usually lidocaine hydrochloride) to subcutaneous tissue is proceeded; subsequently with the introduction of the tunneller at the exit site through the tissues; with the guidance of ultrasound, the needle punctures the choosen insertion site, and insert the guide wire, remove the needle; insert the catheter as the standard procedure[20].

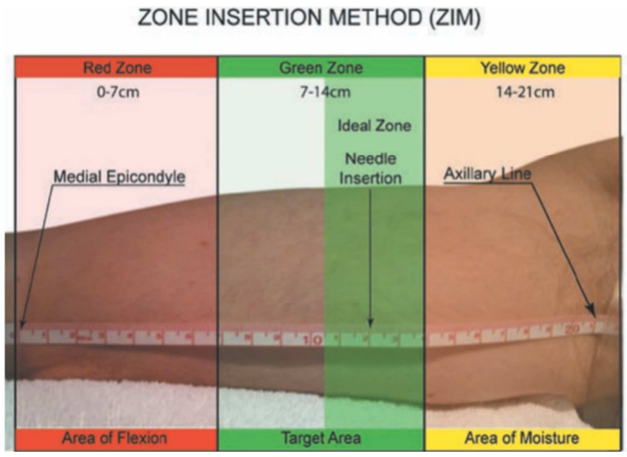

Figure 1. *The PICC Zone Insertion Method (ZIM) proposed by Dawson [18].*

In addition to the same indications as the PICC, the tunnel PICC is particularly suitable for patients with poor peripheral vascular conditions, prolonged bed rest, trauma, burns, localized skin damage, scarring, and low immunity. However, it also brings about an additional manipulation and the presence of a small surgical wound in the axillary area that, in some cases, may determine an incomplete closure, leaving uncovered a portion of the catheter in the subcutaneous level [21].

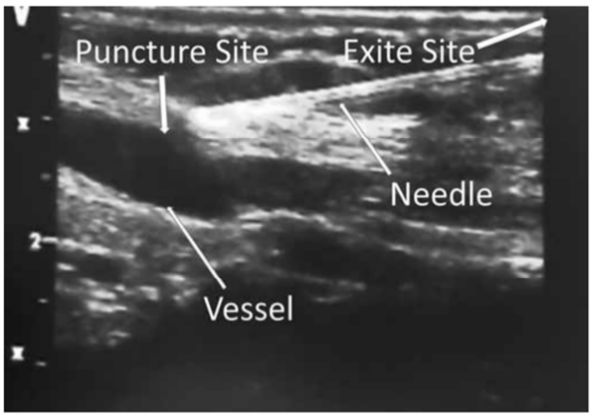

Figure 2. *Needle subcutaneous progress (in plane/long axis view) [21].*

3. Technical Advantages

3.1. A Better Exit Location

The extended subcutaneous route technique allows maintaining the PICC exit site in the green zone which has less body fluid secretion than the yellow area, less mechanical friction, and a strong sense of comfort. Moreover, the export position becomes highly selective, if there is trauma, burns, scars, etc., which cause skin damage, easy infection or difficult observation of the surrounding tissue of the puncture site can also use the tunneled technique [21]. A prospective evaluation was performed in a single facility for all PICC placements from September 2014 to June 2015. Of the results of 685 PICC requests received during the study, 50 (7.2%) were placed with the modified Seldinger tunneling technique with 96% success. There was no report of increased pain, insertion complications, or therapy failure [22].

3.2. Reduce the Incidence of Thrombosis and Infection

The extended subcutaneous route technique allows selecting a larger vein size which means a greater vein to catheter ratio and blood flow that can reduce the incidence of thrombosis. Besides, shortening the length of the catheter in the blood vessel and reducing mechanical friction could also benefit for reducing the incidence of thrombosis [23].

The PICC exit site is different from the puncture site, which increases the difficulty of retrograde infection of microorganisms along the catheter, and better exit locations also reduce infection rates [24]. A study showed the rate of patients who developed infection decreased from 34% for conventional PICC to 16% in tunnelled PICC patients [25].

3.3. Extended Indwelling Time

The subcutaneous tunnel can fix the catheter better and reduce the displacement rate [19]. Tunneled catheters and totally implanted venous access devices are associated with low rates of infection and thrombosis since they are specifically protected from accidental removal [21]. In a recent study, tunneled PICC showed a significantly longer catheter-days compared to the non-tunneled PICC (mean 47 days versus 27 days) [24].

4. Conclusion

Tunneled PICCs with the extended subcutaneous route technique has been proved the safety and efficacy in European countries and performed an important alternative to normal standard placement for the benefits of reduced risk of thrombosis and infection, as well as extended retention [19-27]. Some researchers have explored the application in China and received satisfactory results. Yang et al used the tunneling PICC technology which was punctured in the iliac vein with the guidance of ultrasound, the first attempt success rate was up to 96% and the second attempt success rate was 100% [28]. Jiang et al conducted a clinical trial comparing the tunneled PICC and traditional PICC. The study demonstrated the subcutaneous tunneled PICC was easy to operate and could effectively reduce the rate of bleeding, catheter displacement, infection and phlebitis [29]. Overall, the tunneled PICC technology should be promoted widely in clinical practice for its convenient, low complications and extended long-term use particularly for patients with high risk of bleeding, infection or displacement. Moreover, research on the progress of tunneling technique and large scale clinical application need to be proposed.

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Conflict of Interest

Hai-Jun Zhang holds the intellectual property rights on the manufacture technology of PICCs licensed to Branden medical scientific Inc. Other authors have no conflict of interest.

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