Ultrasound-guided port-a-cath positioning with the new one-shoot technique: thoracic complications

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Abstract

Objectives. Port-a-cath catheterization is often required for those patients who need long-term therapies (malnutrition, neoplasm, renal failure, other severe diseases). The use of ports for a wide range of indications is not exempt from complications. Ultrasound-guided central venous catheterization (CVC) is a safe and fast technique for the introduction of the catheter inside a central vein. This retrospective study reports our experience with US-guided CVC in patient eligible for port-a-cath implantation.

Materials and methods. From January 2007 to March 2017, 108 CVC (out of 770 procedures), were positioned using an ultrasound guide, with the new “one-shoot technique” (group 1) and the classic Seldinger technique (group 2).

Results. One-shoot techniques showed a reduced operative time, in comparison to Seldinger technique, with a negligible minor complication rate. No major complication were evidenced.

Conclusions. CVC is a safe procedure, although not free from complications. Ultrasonography enhances safety of the procedure by decreasing puncture attempts and complications; it is helpful in patients with vascular anatomical variations, with no visualized or palpable landmarks or for patients with coagulation disorders.

Key words: Central Venous Catheterization, CVC, Port-a-Cath, Thoracic complications, Ultrasound guidance

Introduction

Port-a-cath catheterization is a procedure often required especially for those patients who need long-term therapies (malnutrition, neoplasm, renal failure, other severe diseases). (1, 2) Port-a-Cath is a totally implantable device, usually fixed into the subcutaneous layer on the chest wall, connected to a conventional central venous catheter in order to allow injection of chemotherapy drugs or nutritive substances. The use of ports for a wide range of indications is currently not exempt from complications whose nature is well documented by international literature.(3-7) Ultrasound (US)-guided central venous catheterization (CVC) is a safe and fast technique for the introduction of the catheter inside a central vein. It is used in different medical and surgical units with good cost/effectiveness rate. Ultrasounds allows the placement of a central venous catheter in a more secure and faster way, plays a decisive role when anatomical landmarks are not visible or palpable, in cases of vascular anomaly, in subjects with abnormal coagulation parameters and where the expectation of complications may be higher compared to the traditional technique. This retrospective study reports our experience with US-guided CVC in patient eligible for port-a-cath implantation.

Materials and methods

For our retrospective study, 770 CVC were considered over a period of 10 years (from January 2007 to March 2017). US-guided CVC insertion was employed for 108 patients needing port-a-cath placement; 29 of these procedures were performed during the first 4 years, whereas the remaining 79 were performed during the following 6 years. All the patients included in the study were oncological (87.04%), malnourished (2.18%) or affected by metabolic diseases (10.18%). Indications for port-a-cath placement were the administration of chemotherapy in oncological patients and the necessity to administer parenteral nutrition in patients with malnutrition and metabolic diseases.

Two patients were excluded because of neoplastic thrombosis of brachiocephalic vein.

There were no statistically significant differences between the two groups in gender, age and body mass index.

For CVC, only biocompatible titanium containers and 2.8 mm silicone catheters were used. All catheters were placed by the same thoracic surgeon with an experience of more than 50 US-guided procedures. Only 10 MHz linear probes were used for the identification of the internal jugular vein (in real-time B mode).

To insert the catheter, one-shoot technique was used in 70 patients (group 1), (8) between February 2011 and March 2017, whereas the classic Seldinger technique (9), performed between January 2007 and January 2010, was employed in 38 patients (group 2).
On both groups, procedures were performed with a standard aseptic field and local anaesthesia (2% mepivacaine); all patients were placed in Trendelenburg position, with their heads rotated toward the opposite side.

One-shoot US-guided technique provides the direct introduction of a 18G needle (with its 0.36 inches guide wire positioned inside it, close to the tip) into the central vein, without performing blood aspiration.(8)

The classic Seldinger technique was performed, as usual, by introducing a 18G catheter into a central vein, followed by blood aspiration and the subsequent introduction of the guide wire. (9)

In both techniques we introduced a double lumen venous catheter, fixed to the chest subcutaneous tissue by absorbable stitches, and connected to a port-a-cath system, placed in a pouch over pectoralis muscle (prefascial pouch), thanks to a subcutaneous tunnel.

Complications were defined as early or late. Complications were considered “early” when occurring during or immediately after the procedure; these included vasovalg hypotension, vein puncture, hematoma (minor complications), post-procedural bleeding, pneumothorax, haemothorax and puncture of an artery or a nerve (major complications). Late complications, occurring within one week after the procedure, included occlusion/malfunction, catheter-related blood stream infections (minor complications), vein thrombosis and pulmonary embolism (major complications).

Unusual vessel localization, orientation or size were considered as “anatomical variations”. (10)

Antibiotic prophylaxis was applied only for selected patients (diabetic, affected by neoplasm, with high American Society of Anaesthesiologists score or immunosuppressed). (11)

All patients included in the study signed informed consent before undergoing the procedure.

The data were retrospectively analysed using Student’s t-test and chi-square test with Yates’ correction for categorical variables.

Results

Early and late outcomes are reported in Table 1, which includes success rates, number of needle passes, operating time, early and late complications.

Average operating time was 3 minutes in the one-shoot technique group (70 patients); 4 minutes were employed to perform Seldinger technique in the second group (38 patients) (P < 0.05). In both groups the procedure included standard aseptic techniques, local anaesthesia, US-guided identification of the vein and CVC placement (without port insertion). Once the learning curve was completed, the average time was reduced to 2 minutes in the one-shoot technique CVC (p < 0.05). The success rate was 100% in both groups (70/70 and 38/38). All the procedures needed only a single passage of the needle.

There were no major complications, such as infections, thrombosis, pneumothorax or bleeding due to arterial punctures. Early minor complication rate occurred in 8.57% of cases (6/70) in group 1 (2 subcutaneous hematomas, 4 vasovalg hypotension) and in 10.5% of patients (4/38) in group 2 (2 subcutaneous hematomas, 2 vasovalg hypotension) (P = 0.79). Late minor complication rate was 1.43% (1/70) in

Table 1. Outcome after CVC insertion (group 1 and 2).

<table>
<thead>
<tr>
<th></th>
<th>ONE-SHOT TECHNIQUE CVC (n=70)</th>
<th>SELDINGER TECHNIQUE CVC (n=38)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of CVC</td>
<td>0</td>
<td>38 (100%)</td>
<td></td>
</tr>
<tr>
<td>(Jan 2007 – Jan 2010)</td>
<td></td>
<td></td>
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<tr>
<td>Number of CVC</td>
<td>70 (100%)</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>(Feb 2011 – Mar 2017)</td>
<td></td>
<td></td>
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<tr>
<td>Average time for the CVC</td>
<td>3.0 ± 0.8</td>
<td>4.0 ± 0.25</td>
<td>&lt; 0.05</td>
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<tr>
<td>(min)</td>
<td></td>
<td></td>
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<tr>
<td>Average time for the CVC</td>
<td>2.0 ± 0.8</td>
<td>4.0 ± 0.25</td>
<td>&lt; 0.05</td>
</tr>
<tr>
<td>after the learning curve</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>(min)</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Early major complications</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>n (%)</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Early minor complications</td>
<td>6 (8.57%)</td>
<td>4 (10.5%)</td>
<td>0.79</td>
</tr>
<tr>
<td>(hematoma; vasovalg hypoten-</td>
<td></td>
<td>(2 hematomas; 2 vagal hypotension)</td>
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<td>sion)</td>
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</tr>
<tr>
<td>Late major complications</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>n (%)</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Late minor complications</td>
<td>1 (1.43%)</td>
<td>0 (catheter obstruction)</td>
<td></td>
</tr>
<tr>
<td>n (%)</td>
<td>70 (100%)</td>
<td>38 (100%)</td>
<td></td>
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<tr>
<td>Single needle passage, n</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>(%)</td>
<td>70 (100%)</td>
<td>38 (100%)</td>
<td></td>
</tr>
<tr>
<td>Successful, n (%)</td>
<td>2 (2.8%)</td>
<td>2 (5.2%)</td>
<td>&lt; 0.05</td>
</tr>
<tr>
<td>Anatomic variations, n (%)</td>
<td>2 (2.8%)</td>
<td>2 (5.2%)</td>
<td></td>
</tr>
</tbody>
</table>
Ultrasound-guided port-a-cath positioning

group 1 (catheter obstruction). No late complications were registered in group 2.

An anatomical variation of the internal jugular vein was found in a total of 4 out of 108 cases (3.7%), two for each group (p = 0.75).

Discussion

The CVC connected to a port-a-cath is commonly used in critically ill, oncological or immunosuppressed, patients, who need long-term intravenous therapy, frequent blood samplings, drugs infusion and total parenteral nutrition. (12,13) Although CVC is a routine procedure, acute severe complications (including accidental arterial puncture or cannulation, hematoma, hemothorax, pneumothorax) occur in a great amount of patients.(14-16) These are often due to unidentified vascular anatomical variations. (10,17,18) The use of US reduces the number of complications and increases the safety and the effectiveness of CVC placement. It guarantees a higher success rate with a shorter duration of the procedure, especially in high-risk patients.(19-21) In addition, US can improve CVC placement especially in those situations in which classical techniques based on palpation of the arterial pulse are difficult or impossible (e.g., femoral CVC placement during cardiopulmonary resuscitation (22) or in patients with a nonpulsatile ventricular assist device).

Ultrasoundography guarantees a better effectiveness of the procedure by decreasing puncture attempts, complications and the average time of the procedure. It allows the operator to easily visualize anatomic structures and confirm patency of the vein, avoiding inadvertent arterial punctures or cannulation.

The US-guided one-shot technique CVC is easy to perform, especially for skilled operators, and has a short learning curve, as observed in our unit.(8,23)

The benefit of the US-guided one-shot technique is the real-time visualization of the needle and wire during their simultaneous introduction in the vein. The use of the internal jugular vein is advisable, because it allows a better resolution, avoiding any possible cause of pneumothorax, and represents an easier access. Obviously, the catheter should be always handled with extreme care, trying to avoid contamination or accidental displacement. Therefore, a deep cleaning of the wound with sterile procedures and a washing of the catheter lumen with sterile heparinized solutions (100 U/ml). The use of a needle guide, especially for inexperienced users (24), could help the operator to guide the needle along the path of the US beam at the correct angle and distance. Needle guides facilitate faster cannulation of internal jugular vein (25) and subclavian vein.(26) On the other side the classic Seldinger technique requires blood aspiration, with the risk of vein lesion or malposition of the needle, during the other steps of the procedures.(9,22,27-29)

US might lead the inexperienced operator to omit those general and traditional rules with regard to needle direction. The detection of the needle (or needle tip) constantly during needle advancement, is crucial to avoid accidental arterial puncture, posterior wall penetration, or pneumothorax. In addition, rapid movements of the needle, to allow a better detection, must be avoided rigorously. To overcome these problems related to insufficient US skills and to ensure high-quality care, formal education and training (including simulation) with a structured certification of US skills for vascular access and the development of a consensus standard for these training programs has been suggested (30).

Conclusion

Ultrasound allows the placement of a central venous catheter in a safer and faster way. It plays a decisive role when anatomical landmarks are not visible or palpable, in presence of vascular variations, alterations of coagulation and when complications’ expectancy might be higher than with the traditional technique (31).

The new US-guided one-shot technique improves the time of procedure, the patients’ compliance and the outcome.

References