Case Report

Ultrasound Guidance for Central Venous Catheterization: A Step Further to Prevent Malposition of Central Venous Catheter before Radiographic Confirmation

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Abstract

Ultrasound (USG) guidance has long been used for guiding central venous catheterization. USG provides direct visualization of needle puncture through the skin into the vein. Most of the time USG guidance is just limited to puncturing of the vein and seeing guidewire entering the vein while malpositioning of catheter occurs after that which is seen later on while checking chest radiograph. Repositioning of catheter after that becomes not only difficult requiring repeated chest radiograph to reconfirm position of catheter but also increases chances of infection with repeated manipulations. USG guidance can be used for tracing both guidewire and catheter during the procedure to prevent malpositioning of catheter, thus when done at the right time can prevent complication related to malpositioning and repeated manipulations. We used linear USG probe to check malposition of guidewire and microconvex probe to confirm position of central venous catheter.

Keywords: Central venous catheter, malposition, ultrasound

Introduction

Central venous catheterization is one of the most common procedures which is done in Intensive Care Units for delivery of drugs, blood products, monitoring central venous pressures, for dialysis, etc. Most of the central venous catheters (CVCs)' insertion is still being done as blind procedures using anatomical landmarks. With the availability of ultrasound guidance (USG), more and more procedures are now being done under USG guidance. The complications of central venous cannulation are numerous and include malpositioning, a known complication with the reported incidence ranging widely from <1% to >60%.[1] In a systematic review performed by Ruesch *et al*., it was reported that catheter malposition rates were 5.3% and 9.3% for internal jugular vein (IJV) and subclavian vein catheterization, respectively.[2] A misdirected CVC not only lead to wrong CVP measurements but also could lead to serious complications including clot formation, hemothorax, and intracranial septic thrombophlebitis.[3]

As per the American Society of Anesthesiologists (ASA) 2012 practice guidelines, USG should be used to puncture the vessel and then confirm position guidewire in vessel.[4] However, these do go beyond to confirm the path of guidewire and further confirmation of catheter position, which is usually done on X-ray confirmation.

Considering the theoretically significant incidence of central line malposition, USG examination needs to be extended beyond the localization of the vein and should be used for confirmation of correct position.

Case Report

A 54-year-old female admitted with acute abdomen with possible diagnosis intestinal obstruction. Patient required central line insertion. Central line insertion was attempted under USG guidance in right subclavian vein. The patient started complaining of irritation near right ear as soon as

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guidewire was inserted. The right IJV was visualized under USG. A hyperechoic object was seen which was confirmed to be guidewire [Figures 1 and 2]. Guidewire was taken out till not visible in IJV. Reattempts were done while keeping probe over the right IJV using routine methods putting pressure supraclavicular, moving head toward the right side, and assuring position of J point toward the right atrium. Catheter was inserted over guidewire and guidewire was removed. Venous aspiration from all the three ports was done.

We went step further to check position of catheter in the superior vena cava. Saline was flushed through catheter and looking for immediate turbulence in the right atrium using microconvex probe thus confirming position of catheter tip in the superior vena cava.

Discussion

Central venous catheterization is being performed as a routine procedure for different purposes. Most commonly malposition of a catheter is seen on radiograph of the chest. Many a times, CVC is left malpositioned in either IJV or subclavian vein since it serves the purpose of delivering drugs. However then, this increases chances of thrombus formation in vein and can also lead life-threatening complications as pulmonary thromboembolism and septic thrombophlebitis. Manipulation of CVC to reposition it later on increases the chances of infection as most of the time, these attempts are not done in proper aseptic conditions and since the catheter has already come in contact with blood keeping it out for even few minutes will increase its chances of getting layer of bacteria over it and thus increasing chances of infection. These changing attempts will also require repeated chest X-rays to reconfirm correct position.

The most common misplacement of the subclavian vein catheter is into the IJV (5.4%) and does not vary with the side of insertion or whether the head is turned toward or away from the side of insertion.[5] The IJV occlusion test (applying external pressure on the IJV for approximately 10 s in the supraclavicular area and observing the changes in the CVP and its waveform pattern) successfully detects misplacement of a subclavian vein catheter into the IJV. However, it does not detect any other misplacement.

ASA update in 2012 has suggested USG use in CVC insertion. They have also given a wonderful flowchart to prevent malposition and trauma related to CVC insertion. The ASA suggests USG to be done for piercing of the vessel with needle and then seeing the guidewire and catheter going inside the vein. However then, malposition of guidewire, which is often followed by malposition of catheter, occurs once the guidewire is pushed further into the vessel. While we further try to push the guidewire toward superior vena cava, it can get malpositioned within the vessel by getting coiled, can pierce the vessel wall and can go in thoracic cavity or mediastinum or going in some other vessel rather than superior vena cava. All this is usually picked up chest radiograph. Electrocardiographic guidance to confirm position of CVC tip has been widely used. However, the classic increase in p-wave size does not correspond to entry in the right atrium but rather indicates pericardial reflection and it also does not differentiate between arterial and venous placement.[6] Ultrasound gives us a real-time acoustic shadow even if the guidewire is in some other vessel.

Here through our experience in using USG for CVC insertion and taking into consideration the above-mentioned cases, we suggest that ultrasound should be used beyond seeing the catheter in the punctured vessel. The use of ultrasound should be at six steps: (1) to check for anatomy of vessel and structures around, including thrombus within the vessel, (2) seeing the needle piercing the vessel (in-plane or out of plane), (3) seeing guidewire going within the vessel (in-plane), (4) to rule out guidewire in other accessible vessels of neck and thorax, (5) seeing CVC going in the vessel, and (6) checking for immediate prominent turbulence within 2 s in the right atrium by flushing 10 ml saline in distal port.

Step 1 rules out any structural variation and thrombus in accessible area of the vessel. In Step 2, we check for needle

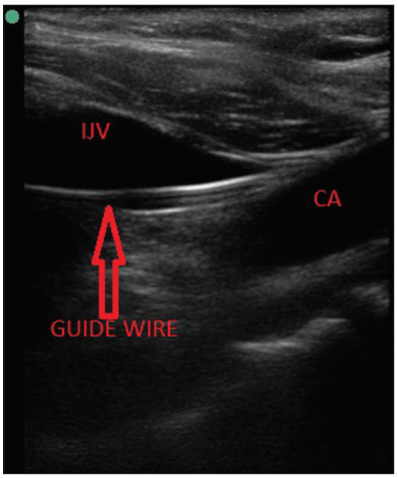

Figure 1: In-plane USG image showing position of guidewire in the internal jugular vein. Abbreviations: IJV: Internal jugular vein; CA: Carotid artery

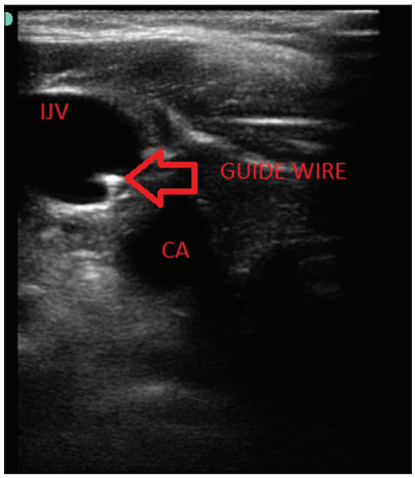

Figure 2: Out of plane image showing guidewire in the internal jugular vein. Abbreviations: IJV: Internal jugular vein; CA: Carotid artery

going inside the venous vessel, and at the same time, also check that posterior wall is not hit or pierced thus leading to hematoma and hemothorax. We can also see pleura so, especially in subclavian cannulation, thus preventing pleural damage.

In Step 3, we see real-time movement of guidewire within the vessel, we recommend in plane visualization of guidewire within the vessel to check for any traumatic complication in the visible field and also check for any abnormal path taken within the vessel.

In Step 4, we move our vascular probe is all accessible vessels of the neck and thorax where malposition is known to occur.

In Step 5, we reconfirm position of catheter in the vessel after dilatation and also check for any trauma because of dilatation.

Step 6 is very important in few cases where catheter pierces the wall of the vessel to lie in mediastinal space or in the pleural cavity. In this step, the person putting the central flushes the distal port of catheter with 10 ml saline while the second person looks at cardiac chambers using microconvex probe. Rapid, i.e., within 2 s of flush, appearance of prominent turbulence is seen in the right atrium which confirms the tip of catheter at optimal position.[7]

While putting forward these steps, we reaffirm that routinely used methods such as color of the blood, checking for any pulsating blood flow, and checking backflow of the blood in all parts should be used as recommended. These steps can be used as additional methods to prevent trauma and malposition of CVC.

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Conflicts of interest

There are no conflicts of interest.

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