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USE OF ULTRASONOGRAPHY FOR CONFORMATION OF CENTRAL VENOUS CATHETER PLACEMENT FOR HEMODIALYSIS - SINGLE CENTER EXPERIENCE

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Abstract

Conformation for safe placement of central venous catheter for hemodialysis and exclusion of pneumothorax is done with chest x ray. However, this procedure is time consuming, so in order to shorten this time several attempts have been tried to use bedside ultrasound.

To use bedside ultrasonography to confirm tip location of central venous catheter and rule out pneumothorax. The second aim was to compare these results with plain chest x ray.

In 50 patients on hemodialysis central venous catheter were inserted in internal jugular vein or subclavian vein under ultrasound guidance.

After insertion, a subxiphoid 4 chamber view was obtained looking to detect turbulence or microbubbles shortly after 10ml saline flush through catheter. Then, ultrasound of the patient's chest was performed to exclude pneumothorax. After the exam, a plain chest x raywas performed for the conformation of the findings.

From 50 placed hemodialysis catheters, 47 were adequately placed. All catheters were identified with the use of ultrasound. The tip of the 3 misplaced catheters could not be detected with the use of ultrasound.

No pneumothorax was observed. The average time for detection of correct catheter placement was much faster with the use of ultrasound compared with chest x ray (11,5min and 80 min, accordingly).

The use of bedside ultrasound for conformation of central venous catheter placement and excluding pneumothorax is as accurate as with chest radiography, but it is can be done much faster.

Keywords: catheter placement, bedside ultrasonography, hemodialysis, microbubbles, pneumothorax.

Introduction

The safe placement of central venous catheter (CVC) remains vital part of care for patients with chronic kidney disease (CKD) on hemodialysis (HD). Although it is a procedure which is performed routinely, it is not without complications.

This is especially true for placement of catheters in internal jugular (IJ) and subclavian (SC) vein . The possible complications are pneumothorax , hemothorax, misplaced tip or arterial placement. The introduction of ultrasound guided CVC placement has reduced the rate of arterial placement and pneumothorax, but the possibility of misplaced tip still remains [1-3].

Possible sites for misplaced tip are v. azygos, v. innominate, contralateral or rarely ipsilateral SC or IJ vein . Acceptable sites for tip positions are: right atrium, vena cava superior (VCS), brachiocephalic vein or subclavian vein. [4-6].

After the catheter placement, a plain chest x-ray (CXR) is performed to rule out pneumothorax and to validate the position of the catheter tip, but this procedure is time consuming and can take up to several hours and thus delay the start of the hemodialysis session which in some patients is urgent procedure.

Recently, several attempts have been made to shorten the time for CVC placement conformation, and this is mainly done with the use of bedside ultrasound (US). Detecting lung sliding with the help of lung ultrasound (LUS) can easily rule out pneumothorax [7-9].

The visualization of turbulence or micro-bubbles within right atrium (RA) within 2 seconds of flushing saline through the catheter can confirm adequate CVC placement within the venous system with 96% sensitivity and 93% specificity [9-11].

Objectives

The aim of this study is to show the first results of the use of US in conformation of safe catheter positioning in comparison with the CXR in our department.

We hypothesized that US conformation of CVC placement can be compared with the CXR conformation, but it can be done much faster.

Materials and methods

We performed a prospective, observational, single cohort study. A total of 50 patients were screened. Vascular accesses were internal jugular vein (27 right and 10 left) and subclavian vein (8 right and 5 left).

Previous vein cannulation, infections and thrombophlebitis ruled out femoral vein placement.

All catheters were inserted with US guideline. No acute complications were observed at the time of cannulation. The catheter length was 15 cm and 20 cm, depending of the location .

All US views were obtained using Mindray DC -T6 US machine, using linear and curved probe. The subxiphoid 4 chamber view of the heart was obtained, demonstrating the both ventricles and atria.

Then, the distal port of the CVC was flushed with prefilled 10ml sterile saline flush by the nurse, while the physician continued to monitor the heart, looking for the appearance of turbulence or micro-bubbles from the infused saline flush. If the flush was not viewed immediately, its delay or nonappearance was noted.

The appearance of the saline swirl entering the right atrium within 2 seconds of the start of the saline flush was interpreted as being indicative that the CVC tip was close to, or within, the target zone. The time interval chosen was based on a previous investigation by Vezzani et al.[10].

Next, US of the anterior wall of the patient's chest was performed to evaluate for pneumothorax. We used linear probe in sagittal plane in the most superior part of the pleura to visualize the sliding of the pleural walls indicating a normal pleura.

The absence of lung sliding was interpreted as a pneumothorax.

After the exam, a plain CXR was performed for the conformation of the findings.

Results

From 50 placed hemodialysis catheters, 47 were adequately placed. All 47 catheters were identified with the use of US.

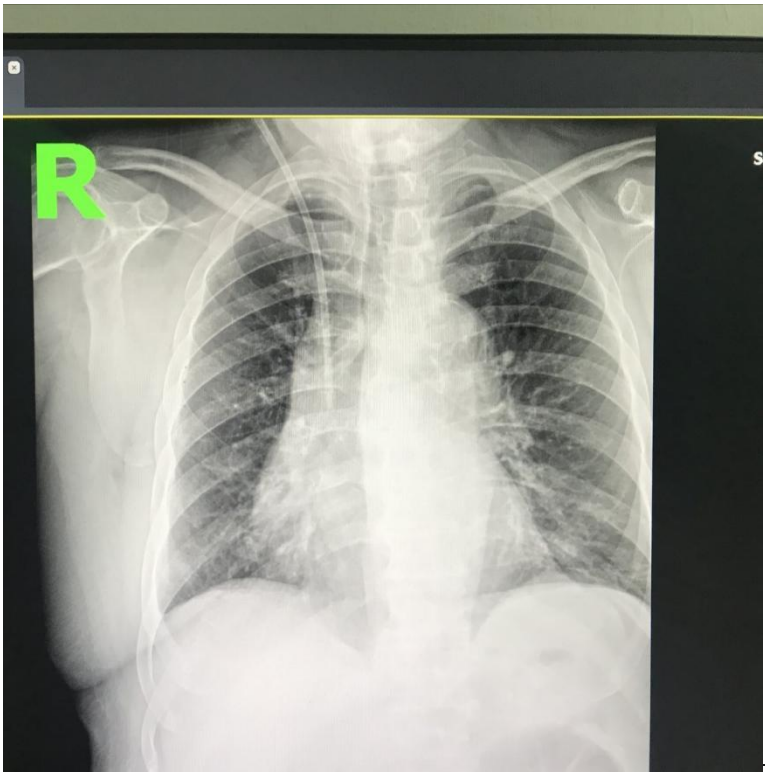
The malpositioned catheters were 2 in contralateral jugular vein, 1 in axillary vein. First two were placed in subclavian vein, and the last in internal jugular vein. In all the cases no microbubbles were detected.

No pneumothorax was observed.

The average time for appropriate catheter placement conformation was 11,5 minutes with agitated saline enhanced ultrasound compared to more than 80 minutes with CXR.

Picture 1. 4 chamber US view of the heart.

Picture 2. 4 chamber US view of the heart 1,5 second after the saline flush showing the saline swirl.



Picture 3. CXR showing IJ vein catheter placement with the tip placed in VCS

Discussion

We performed a prospective study in which we compared 2 point bedside ultrasound with chest x ray in conformation of hemodialysis catheter placement and ruling out pneumothorax. In our study the use of US was much faster and equally precise than CXR. This finding is in accordance with the other previous studies [9- 13].

Also, it can reduce the radiation exposure . The four chamber cardiac view and evaluation of lung sliding are basic emergency US skills, although some training is needed. This protocol adds only little time to the catheter placement protocol, but can quickly confirm correct CVC placement or alarm misplaced placement or eventual pneumothorax formation.

Unfortunately, this procedure cannot clarify the precise location of CVC, but as long as it is placed In the lower portion of VCS, there should be no real worry [4-6].

Our study revealed 100 % sensitivity and 100% specificity for detection of abnormal catheter placement and PTX formation. This would suggest that in uncomplicated cases, especially with right jugular vein placement it may be unnecessary to perform CXR post line placement [14,15].

Conclusion

Visualization of microbubbles or turbulence in the heart with bedside ultrasound is highly accurate in identifying correct positioning of central venous catheters and it is significantly faster than chest x ray. It is also very accurate in excluding pneumothorax.

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