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Changes in the position of the internal jugular catheter tip due to head movement : a retrospective study

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ABSTRACT

Background: Endotracheal tube displacement due to head and neck movement has been well described. However, no similar study has been conducted with regard to the effect of head movement on internal jugular catheters. We hypothesized that head movement would also affect the internal jugular catheter tip position. This study aimed to determine whether head movement affects the internal jugular catheter tip position in pediatric patients less than 6 years old.

Method: Twenty-four pediatric patients (aged 0-6 y) undergoing elective cardiac surgery were enrolled. Radiography was performed in both neutral and left head rotation positions. Using radiographs, we measured the change in distance between the catheter tip and the level of the upper edge of the 12th vertebra. Changes in catheter tip position between the neutral and left head rotation position were analyzed using a paired *t*-test.

Results: There was no statistically significant displacement ($P = 0.3$). The maximum displacement of the catheter tip position was 2.42 cm.

Conclusion: Our data showed that left head rotation did not significantly displace the catheter tip position in most cases. However, in some cases, head movement caused catheter advancement or withdrawal, which could lead to severe complications.

Keywords: pediatrics, jugular vein, displacement, catheter tip

Introduction

Central venous catheter (CVC) placement provides reliable venous access for medications as well as measurement of the hemodynamic status. Several complications are associated with CVC.¹⁾⁻³⁾ Among them, catheter tip displacement can sometimes cause lethal outcomes. Catheter tip displacement can occur in either direction. Advancement of the catheter causes mechanical complications such as vascular perforation and cardiac tamponade,⁴⁾ whereas withdrawal of the catheter increases the risk of thrombosis and infection and can result in insufficient administration of medication.

Increased intrathoracic pressure due to coughing and sneezing, decreased intrathoracic pressure due to tracheal extubation, changing the body position, or physical movement is thought to be the cause of catheter tip displacement.^{4), 5)} However, the exact mechanism of displacement remains unclear. However, endotracheal tube displacement due to head movement has been well described.⁶⁾ Based on that, we hypothesized that head movement would also affect the internal jugular catheter tip position. The risk is particularly high in pediatric patients as they are more likely to move and be uncooperative.

The present study aimed to determine whether head movement affects the internal jugular catheter tip position in pediatric patients.

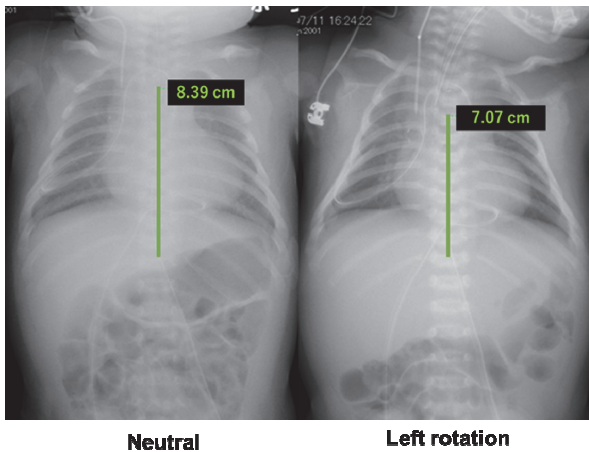


Figure 1. Method of measuring the distance from the 12 th vertebral upper edge to the tip of the catheter tip.

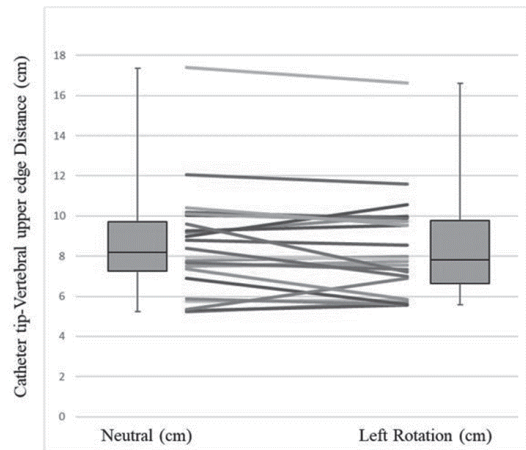


Figure 2. Individual displacements of the catheter tip from the neutral position. In these box-and-whisker plots, the box boundaries display the first and third quartiles, and the whiskers represent the minimum and maximum values. The horizontal line within the box represents the median value.

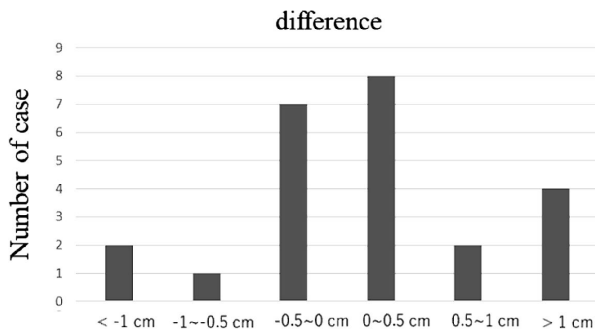


Figure 3. The number of cases by catheter movement distance.

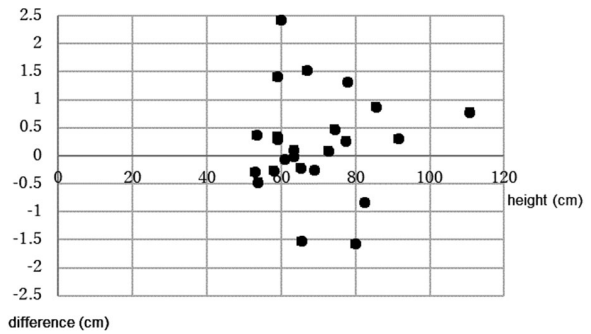


Figure 4. Scatter diagrams between the distance of the catheter movement and the patient's height.

Materials and Methods

This retrospective study was performed at a single center. All pediatric patients (aged 0-6 y) undergoing elective cardiac surgery at Yamagata University Hospital (Yamagata, Japan) between January 2014 and October 2017 were included in this study. Table 1 shows a flow diagram of the study. Patients who underwent catheter insertion into the right internal jugular vein and who had undergone radiographic examination in both neutral and left head rotation positions were enrolled. Using radiographs, one physician measured the change

in distance between the catheter tip and upper edge level of the 12th vertebra (Figure 1). Studies have measured the distance between tracheal bifurcation and catheter tip position. In this study, tracheal bifurcation could not be identified due to the influence of thymus or mediastinal shadow depending on the case. Therefore, the upper edge of the 12th vertebral, which is easy to identify, was used as a reference without shifting the position due to breathing or head position conversion.

Data are expressed as mean \pm SD (range). A clinically significant displacement was defined as a displacement of >1 cm. This minimal clinically important displacement was selected on the basis

Examination of catheter movement

Table 1. Flow diagram of the study

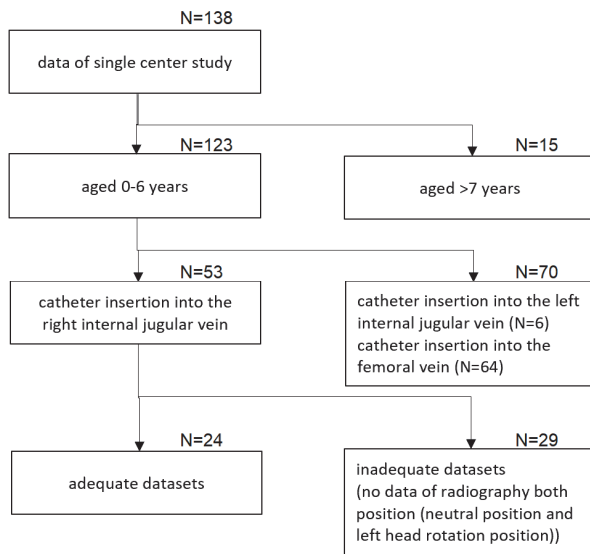


Table 2. Patients characteristics

Age (year)	1.0 ± 1.1 (0-5.3)
Weight (kg)	7.8 ± 3.9 (4.2-20.2)
Height (cm)	69.3 ± 13.8 (53-110.8)
Sex (M/F)	14 / 10

Data are presented as mean ± SD (range) and number

that the length of catheter retention is shorter in children than in adults.⁷⁾ Changes in the catheter tip position from the neutral position were analyzed using the paired t test. P value < .05 was considered as statistically significant.

Because of the anonymous nature of data, the requirement for informed consent was waived. Study approval was obtained from the institutional review board of the Yamagata University Hospital (No.2018-145).

Results

Twenty-four pediatric patients were enrolled in this study (Table 2). All patients underwent insertion of a 17-G double lumen catheter under ultrasound guidance. The depth of CVC insertion was determined using the surface landmark method. Radiographs were obtained in the operating room and intensive care unit. The extent of individual displacement of the catheter tip from the neutral position is shown in Figure 2. The catheter tip moved toward the upper edge of the 12th vertebra by 0.18 ± 0.89 (-1.58-2.42) cm (P = 0.3). However, there was no statistically significant catheter tip displacement. The number of cases with catheter movement displacement and distance of displacement are shown in Figure 3. Clinically significant catheter

tip displacement (>1 cm) occurred in 25% (6/24) of patients. The maximum displacement of the catheter tip position was 2.42 cm. The displacement occurred in an unpredictable manner (advancement in 4 patients and withdrawal in 2). There were no complications associated with catheter displacement. Scatter diagrams between the distance of catheter displacement and patient's height is shown in Figure 4. There was no correlation between the height and distance of catheter displacement (r=0.03).

Discussion

This retrospective study investigated whether head movement was related to internal jugular catheter tip migration in pediatric patients (aged 0-6 y). The results showed that left head rotation did not significantly affect the internal jugular catheter tip position in pediatric patients. However, in some cases, left head rotation displaced the catheter tip to over 1 cm.

The mechanism of catheter tip displacement remains unclear. Most existing studies on CVC displacement are case reports.^{3), 4)} A previous prospective randomized study has shown that decreased intrathoracic pressure due to tracheal extubation was not associated with a significant postoperative CVC tip displacement in adult patients.⁸⁾ Our results showed that left head rotation did not significantly affect the internal jugular catheter tip position. However, the result that cannot be missed is that catheter tip displacement of >1 cm due to left head rotation was observed in 25% of patients. Pediatric patients, especially infants and young children, have difficulty in keeping the

head at rest, and the length of catheter retention is shorter in these patients than in adult patients.⁷⁾ The catheter indwelling length for patients aged <0–6 y is approximately 4–8 cm, and considering the subcutaneous indwelling length, the distance actually indwelled in the blood vessel is considered short. For the reasons stated above, we speculate that even >1 cm of catheter tip displacement may be important from a clinical point of view for pediatric patients.

The relationship between height and catheter displacement was not shown in this study. Previous studies have reported that head rotation >45° increases the overlap between the internal jugular vein and common carotid artery.⁹⁾ This anatomical shift due to head rotation may have influenced catheter tip displacement in some cases. In contrast, we cannot deny the possibility that differences in the puncture position and fixation method of the catheter, which we did not investigate in this study, could have influenced catheter tip displacement.

This study has several limitations. Data collection was performed by a single unblinded observer, which may have introduced bias. In addition, we collected data regarding CVC insertions only into the right internal jugular vein, which is the usual site of insertion. We noted a few cases wherein the CVC was inserted into the left internal jugular vein, but we could not investigate those cases. Finally, the left head rotation angle was not uniform, head flexion and extension were likely present in some cases, and puncture position was not constant. In clinical practice, it is impossible for the head movement to be limited to a certain angle or to puncture at the same place at all times. Therefore, it can be said that our result is based on actual clinical practice.

Conclusion

Our data showed that left head rotation did not significantly displace the catheter tip position in pediatric patients. However, in some cases, left head rotation caused catheter advancement or withdrawal, which could lead to severe complications. Physicians and nurses who perform perioperative catheter management should keep in mind that changing the head position may sometimes causes the catheter

to move. Detailed analysis of factors that can affect catheter displacement should be performed in a further study.

This research was presented at the European Anesthesiology Congress in 2018.

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