

Supraclavicular versus Infraclavicular Subclavian Vein Catheterization in Infants

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Background: Central venous catheterization is an important procedure for infant patients for a number of different purposes, including nutritional support, surgical operation, hemodynamic monitoring, and multiple lines for critical care medications. Subclavian vein catheterization (SVC) is one of the central vein catheterization techniques. SVC can be performed from 4 different locations: right supraclavicular (RSC), left supraclavicular (LSC), right infraclavicular (RIC), and left infraclavicular (LIC). The purpose of this study was to evaluate the relative effectiveness and complication risks of these 4 SVC locations in infants.

Methods: In our pediatric intensive care unit, which is part of a tertiary medical center, a well-trained fellow doctor performed the following catheterizations: 21 RSC, 24 LSC, 24 RIC, and 22 LIC, for a total of 91 SVC operations in infants. The patients were placed in the Trendelenburg position. The site of puncture was decided by the operator. Statistical significance was analyzed according to Fisher's exact test and 2-sample t test.

Results: The overall success rate was 90.1% (82 out of 91 operations). No statistically significant differences were noted among these 4 groups, either in the success or complication rate. There were 6 cases of arterial puncture (5 supraclavicular and 1 infraclavicular, $p = 0.09$), 2 cases of pneumothorax (1 RSC and 1 RIC), and 2 cases of malpositioned catheter (1 RSC and 1 RIC). There was no mortality.

Conclusion: In our study, we found that there was no statistically significant difference among the 4 SVC locations in effectiveness of operation or in risk of complication. There was a tendency to damage the subclavian arteries through the supraclavicular route. [*J Chin Med Assoc* 2006;69(4):153–156]

Key Words: central catheterization, complications, infants, pneumothorax, subclavian vein

Introduction

Central venous catheterization is often performed for fluid infusion in patients with poor peripheral access, hemodynamic monitoring, infusion of irritable or hypertonic solutions, and hemodialysis.¹ Since Aubaniac's original description,² subclavian vein catheterization (SVC) has become a well-established technique. The success rate of this procedure is lower in infants than in adults.³ Traditionally, we cannulate the subclavian vein through the infraclavicular (IC) route.⁴ The authors are unaware of any studies

concerning SVC site selection in infants; therefore, we conducted this study to evaluate if there were any significant differences in effectiveness and in risk of complication among the 4 SVC sites.

Methods

In our pediatric intensive care unit (PICU) of a tertiary medical center, we performed the following SVC catheterizations: 21 right supraclavicular (RSC), 24 left supraclavicular (LSC), 24 right infraclavicular

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(RIC), and 22 left infraclavicular (LIC) in infants as a part of this study. We used 4 Fr ARROW (ARROW International Products, Reading, PA, USA) pediatric 2-lumen central venous catheter sets to perform these operations. All procedures were performed by a well-trained fellow doctor by blind methods with the modified Seldinger technique. Each skin puncture was defined as an attempt. We confirmed all successful operations with chest radiography after the catheterization. Statistical significance was analyzed according to Fisher's exact test and 2-sample *t* test. Statistical significance was defined as a *p* value less than 0.05. This study was approved by a local ethics committee. Because SVC was a common procedure for the care of these infant patients, informed parental consent was not required.

Procedure

The patient was placed in a supine position. The site of skin puncture was decided by the operator, based on professional judgment. Critical considerations included ease of operation and risk of complications. A small washcloth or towel was placed between the patient's clavicles, and the head was extended toward the opposite side of insertion. The ipsilateral anterior superior region of the chest was cleaned in a sterile fashion with povidone-iodine. Sterile technique (mask, cap, gloves, and gown) was used by the operator. When the patient was not sedated with midazolam or ketamine, 1% lidocaine was injected at the puncture site. In mechanically ventilated patients, the positive end-expiratory pressure was removed, and the puncture was performed in expiratory pause with FiO₂ of 1. Cannulation of the vein was obtained by the modified Seldinger technique. The puncture site was above or below the midpoint of the clavicle, in the right side or the left. After insertion, the needle was rotated toward the suprasternal notch and advanced posteriorly to the clavicle, always keeping close to the bone and parallel to the coronal plane.^{5,6} Return of venous blood into the syringe attached to the needle confirmed entry into the vein. The syringe was removed, and a guide wire was passed through the needle. The needle was then removed and a vein dilator was passed over the guide wire to create a tract. The vein dilator was then removed and a long catheter was inserted over the guide wire. Then, the guide wire was removed and the catheter connected to the infusion system. Intravascular placement was confirmed by free reflux of blood into the syringe and by chest radiography. The catheter was judged to be in position when its tip was seen inside the superior vena cava.

Results

Patient characteristics are listed in Table 1 in 2 separate groups, namely, the supraclavicular (SC) and the infraclavicular (IC) groups. The SC group had a total of 45 operations, 21 RSC and 24 LSC. The mean age of the group was 6.7 ± 3.5 months, ranging from 1 day to 11.5 months, and the mean weight was 6.6 ± 2.0 kg, ranging from 2.5 to 11 kg. In the IC group, there were 46 operations, with 24 RIC and 22 LIC. The mean age was 6.5 ± 2.0 months, ranging from 1 day to 11.8 months, and the mean weight was 6.5 ± 2.0 kg, ranging from 2.3 to 10.5 kg. Nineteen of the 45 SC operations and 20 of the 46 ICs were performed under the use of a ventilator before central line placement.

The success and failure rates and the number of attempts to success are summarized in Table 2. The overall success rate was 90.1% (82/91), including 95.2% in the RSC group, 91.7% in the LSC, 87.5% in the RIC, and 86.4% in the LIC groups. There were no statistical differences among the 4 groups.

Complications are summarized in Table 3. There were 11.1% (5/45) of the SC and 2.1% (1/46) of the IC operations with a complication of arterial puncture, $p = 0.09$. There were 2 cases of pneumothorax complication, 1 case each in the RSC and the RIC groups. The RSC case had a ventilator in use before catheterization, and the case with pneumothorax was of the immediate type. She had a good recovery after chest tube insertion, with no sequelae. The RIC case did not have a ventilator in use, and the pneumothorax was of the delayed type that seemed to absorb and heal on its own in 3 days. There were also 2 cases of malpositioned catheter, 1 each among the RSC and RIC operations, respectively. The catheter line was malpositioned to the internal jugular vein in the RIC case and to the pleural cavity in the RSC case, which led to pleural effusion. None of the 91 SVC operations in this study incurred local infection within 5 days of the catheterization, and there was not a single mortality throughout this study.

Discussion

Central venous catheterization is an important procedure in the PICU. We often need the central vein for fluid infusion, hemodynamic monitoring, infusion of irritable or hypertonic solutions, and hemodialysis.⁷ We can cannulate central lines through the internal jugular vein, external jugular vein, subclavian vein, or femoral vein.

Table 1. Characteristics of supraclavicular and infraclavicular groups

	Supraclavicular	Infraclavicular
No. patients	45	46
Right side	21	24
Left side	24	22
Mean age, mo, mean \pm SD	6.7 \pm 3.5	6.5 \pm 3.7
Mean weight, kg, mean \pm SD	6.6 \pm 2.0	6.5 \pm 2.0
Use of ventilator before central line placement, <i>n</i>	19	20

Table 2. Success and failure rates, and attempts to success in 4 groups

SVC site	RSC	LSC	RIC	LIC	Total
Failure rate	4.7% (1 in 21)	8.3% (2 in 24)	12.5% (3 in 24)	13.6% (3 in 22)	9.9% (9 in 91)
Success rate	95.2% (20 in 21)	91.7% (22 in 24)	87.5% (21 in 24)	86.4% (19 in 22)	90.1% (82 in 91)
\leq 2 attempts	90.0% (18 in 20)	90.9% (20 in 22)	90.5% (19 in 21)	89.5% (17 in 19)	90.2% (74 in 82)
$>$ 2 attempts	10.0% (2 in 20)	9.1% (2 in 22)	9.5% (2 in 21)	10.5% (2 in 19)	9.8% (8 in 82)

SVC = subclavian vein catheterization; RSC = right supraclavicular; LSC = left supraclavicular; RIC = right infraclavicular; LIC = left infraclavicular.

Table 3. Complications in the 4 groups

SVC site	RSC	LSC	RIC	LIC	Total
No. operations	21	24	24	22	91
Arterial puncture	3	2	1	0	6
Pneumothorax	1	0	1 (delayed pneumothorax)	0	2
Malpositioned catheter	1 (to pleural cavity)	0	1 (to internal jugular vein)	0	2
Mortality	0	0	0	0	0

SVC = subclavian vein catheterization; RSC = right supraclavicular; LSC = left supraclavicular; RIC = right infraclavicular; LIC = left infraclavicular.

In our PICU, we have found that SVC has some advantages over that of using other veins. SVC is known to have a lower risk of infection over femoral venous catheterization.⁸⁻¹² Jugular vein catheterization is difficult to perform in infants with their short neck and larger-than-usual head-to-body proportion. Potential complications from carotid artery puncture, such as cerebral thromboembolism and airway compromise, are more serious than those from subclavian artery puncture. However, articles discussing and comparing merits and risks among the different SVC sites in infants are few and limited.¹³⁻¹⁸ This report helps shed light on the subject.

There were no statistically significant differences among our 4 groups, either in success or complication rates. It is notable that the complication rate of arterial puncture seemed to be higher in the SC groups than in the IC groups, in spite of the 0.09 *p* value. Further studies, however, are needed to assess its statistical significance. One possible explanation is that the subclavian artery and vein are more tightly

bundled in parallel in infants than in adults, making it easy to puncture the subclavian artery by the SC route. When arterial puncture occurred, we stopped the procedure and pressed on the area of puncture directly for 10 minutes. No patients developed significant ecchymosis afterward.

In our past experience, 1 special case involved a premature baby, weighing less than 800 g, who was diagnosed with sepsis (this case was not included in this study). There were no available peripheral veins in the limbs for catheter access because of multiple prior attempts for other purposes. We performed percutaneous central line catheterization through the LIC subclavian vein. To our surprise, the insertion was successful in 1 single attempt without complication.

The literature shows the success rate for central venous catheterization could be raised with the help of sonography.¹⁹⁻²¹ However, we often have to perform SVC in urgent situations when sonography is unavailable. Raising the success rate and lowering the complication rate in blind methods are crucial.

We conclude from this study that SVC has acceptable complication and success rates in infants. Given due professional diligence during surgery, SVC is a safe procedure, even in premature infant patients.

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