A New Technique for Femoral Venous Access in Infants Using Arterial Injection Venous Return Guidance

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Objectives: Although venography guidance is helpful for central venous catheter placement, it is sometimes difficult to place a peripheral intravenous cannula for enhancement. We designed a new technique for establishing femoral venous access using venography guidance in the return phase of peripheral arteriography. This new technique was named arterial injection venous return guidance. Here we assessed the efficacy and safety of arterial injection venous return guidance.

Methods: We reviewed data of 29 infants less than 6 months old undergoing catheter intervention at our institute in 2014. Of the 29 patients, femoral venous cannulation was performed using arterial injection venous return guidance in 5 patients, venography in 20 patients, and the landmark method in 4 patients. The technical success rates and incidence of complications were compared.

Results: The overall success rates were 100% in the arterial injection venous return-guided and venography-guided groups. The mean procedure duration and mean contrast material injection time were similar between the groups. The contrast effect on the femoral vein in the arterial injection venous return-guided group was lower than that in the venography-guided group, but adequate for surgery. The overall complication rate was 17%, and obstruction of previously placed intravenous catheters was the most common complication.

Conclusions: Therefore, the arterial injection venous return guidance technique was as safe and efficient as venography for establishing venous access.

Keywords: femoral venous access, venography, angiography, return phase, small infant

Introduction

Central venous catheter placement is more difficult in children, particularly neonates and infants, than in adults. In recent years, various strategies have been used to reduce the incidence of complications associated with central venous catheter placement. At our institution, the standard policy in patients less than six months old is placement of catheter sheaths using venography guidance.

Venography guidance has the advantage of clear visualization of almost all central veins, which helps visualization of the appropriate vein for central venous access. In addition, technical skills required for this method are not unique. A disadvantage associated with venography guidance is the need for placing an intravenous cannula as peripherally as possible so that all central veins can be enhanced. An additional peripheral venous line is difficult to place in hemodynamically unstable patients, when there are many peripheral intravenous cannulas for drugs.

Therefore, we designed a new technique for establishing femoral venous access using venography guidance during the return phase of arteriography. This new technique was named arterial injection venous return guidance. The purpose of this study was to assess the efficacy and safety of arterial injection venous return guidance for establishing femoral venous access.

Materials and Methods

We retrospectively collected data from medical records of 29 consecutive infants less than 6 months old who underwent catheter intervention at our institute in 2014. The primary outcome measures were overall success rate, necessity for alternative methods of vascular access, and overall procedure time. The secondary outcome measures addressed complications associated with vascular access placement.

Our technique for establishing femoral vein access is based on the modified Seldinger technique, which achieves vascular access using an over-a-wire catheter. During
the procedure, patients were appropriately sedated and restrained. The pelvis was elevated just above the plane of the body, and the femur was externally rotated at approximately 30°. The patient was then scrubbed and draped in standard sterile fashion. The insertion site was anesthetized with 1% lidocaine. Then, physicians attempted to obtain femoral venous access using one of the study methods.

**Arterial injection venous return guidance**
Arterial injection venous return guidance was used in patients for whom an additional intravenous catheter could not be placed in the leg for venography. Through a 24-gauge peripheral artery cannula at the lower extremity for blood pressure monitoring, 2 mL of two-fold-diluted nonionic contrast was manually injected within 5 s. In some infants, the femoral artery was visualized after injection because the contrast media was flashed up against the blood flow. Approximately 15 s after the injection, the venous system was subsequently opacified in the return phase. A 22-gauge needle was oriented parallel to the femoral vein below the inguinal ligament. Once the intraluminal position was confirmed, a 0.025" guide wire was advanced, and a sheath was placed.

**Venography guidance**
An intravenous cannula was peripherally inserted into a vein on the right foot using a 24-gauge needle to inject the contrast material. The venous system was visualized using a two-fold diluted nonionic contrast by hand-injection, and the puncture site was determined. The remainder of the procedure was performed as described in the arterial injection venous return guidance section.

**Landmark technique**
The common femoral vein was located within the femoral angle in the inguinal femoral region. The surface landmarks were identified, and a needle was inserted approximately 5 mm medial to the maximal pulsation point of the femoral artery. The remainder of the procedure was the same as described above.

### Statistical analysis
Statistical analyses were performed using the JMP statistical package (version 11.2.1, SAS Institute, Inc., Cary, NC, USA). Variables were assessed using Wilcoxon rank-sum tests to determine the differences between each method. Statistical significance was accepted if the value of p was less than 0.05. Data are presented as the mean value ± standard deviation.

### Results
Of the 29 patients, venous access was achieved by arterial injection venous return guidance in 5 patients, by venography guidance in 20 patients, and by the landmark method in 4 patients (Table 1). The mean age of patients in the landmark group was statistically greater than that in the other two groups (arterial injection venous return guidance, 0.8 months; venography guidance, 2.2 months; and landmark, 4.0 months; p = 0.01). Between the arterial injection venous return and venography guidance groups, there was no statistical difference in age or body weight. The number of peripheral venous catheters in the leg was greater in the venography guidance group than in the other groups (p < 0.01). On the other hand, there was a significantly greater number of peripherally-inserted central catheters placed in four (80%) of five patients in the arterial injection venous return guidance group (p = 0.05).

All infants in the arterial injection venous return guidance group had been diagnosed with hypoplastic left heart syndrome (Table 2). Of the five infants, three underwent

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**Table 1** Characteristics of patients undergoing central venous access procedures

|                                | Arterial injection venous return guidance | Venography | Landmark |
|--------------------------------|------------------------------------------|------------|----------|
| Number of Pt                   | 5                                        | 20         | 4        |
| Age mean (SD) (m)              | 0.8 (0.4)                                | 2.2 (2.2)  | 4.0 (1.8) |
| Weight mean (SD) (kg)          | 2.5 (0.4)                                | 3.5 (1.2)  | 5.1 (2.1) |
| Catheter purpose               |                                          |            |          |
| BAS                            | 1                                        | 5          | 0        |
| PDA stent implantation         | 3                                        | 0          | 0        |
| Balloon dilation               | 1                                        | 14         | 4        |
| Ablation                       | 0                                        | 1          | 0        |
| Number of IV catheter mean (range) | 1 (all)                              | 2 (2–3)    | 1 (all)  |
| Pt with central venous catheter| 20%                                      | 5%         | 0        |
| Pt with peripherally inserted central catheter | 80%                                       | 30%        | 25%       |

* p = 0.01, ** p < 0.01, *** p = 0.05. Pt: patients; BAS: balloon atrioseptostomy; PDA: patent ductus arteriosus; IV: intravenous
bilateral pulmonary artery banding and one underwent Norwood operation.

The overall success rate was 100% in both arterial injection venous return and venography guidance groups. The mean times for contrast material injection were not different between the two groups. The contrast effect in the femoral vein in the arterial injection venous return guidance group was lower than that in the venography guidance group but was still adequate for surgery (Fig. 1). The success rate in the landmark group was 75%. Placement failed in one infant in the landmark group, and the venography guidance technique was subsequently employed (Table 3). Because of the failed procedure in this group, which took 77 min, the mean procedure duration of the landmark group was longer than that in the other groups, but was not statistically different. Complications occurred in 5 (17%) of 29 infants. Hematoma occurred in one patient with the use of the landmark method, and intravenous catheters for enhancement occluded in four patients with the use of the venography guidance technique.

| Patients | Diagnosis | Previous operation | Chromosomal | Age (month) | Body weight | BSA (m²) | Purpose       |
|----------|-----------|-------------------|--------------|-------------|-------------|-----------|---------------|
| 1        | HLHS      | Norwood           | —            | 1           | 2.0         | 0.15      | Balloon dilatation |
| 2        | HLHS      | bil PAB           | Turner       | 1           | 2.0         | 0.15      | PDA stent     |
| 3        | HLHS      | —                 | —            | 0           | 2.6         | 0.17      | PDA stent     |
| 4        | HLHS      | bil PAB           | Kabuki       | 1           | 3.0         | 0.20      | BAS           |
| 5        | HLHS      | —                 | —            | 1           | 3.0         | 0.22      | BAS           |

BSA: body surface area; HLHS: hypoplastic left heart syndrome; bil PAB: bilateral pulmonary artery banding; PDA: patent ductus arteriosus; BAS: balloon atrioseptostomy

| Arterial injection venous return guidance | Venography | Landmark |
|------------------------------------------|------------|----------|
| Number of Pt                             | 5          | 20       | 4        |
| Overall success n (%)                    | 5 (100)    | 20 (100) | 3 (75)   |
| Times of enhancement mean (SD)          | 1.6 (0.8)  | 1.2 (0.4) | 0        |
| Total time mean (SD) (min)              | 9.6 (4.2)  | 11.0 (13.3) | 27.5 (33.5) |
| Complications n (%)                       | 0 (0)      | 4 (20)   | 1 (25)   |
| Hematoma n                               | 0          | 0        | 1        |
| Obstructions n                           | 0          | 4        | 0        |

Pt: patients

**Table 2** Characteristics of patients undergoing arterial injection venous return guidance

**Table 3** Outcomes of various central venous access methods

**Fig. 1** (A) The venogram obtained by arterial injection venous return guidance. The femoral vein was visualized approximately 15 s after two-fold diluted enhancement material was injected. (B) The venogram obtained by the venography method. The image obtained using the arterial injection venous return guidance was less clear than that obtained using the venography method, but it was sufficient.
Discussion

The National Institute for Clinical Excellence, located in the United Kingdom, has recommended that all central venous punctures should be made using ultrasound guidance. In a meta-analysis including pediatric studies, real-time ultrasound guidance was observed to reduce the cannulation time and improve success rates compared with the traditional landmark technique.

The disadvantages of ultrasound guidance include the accessibility of the machine and the learning curve involved in successfully using the technology. Small, mobile bedside ultrasound imaging devices have resolved the accessibility issue. However, some experts have suggested that a lack of experienced ultrasound operators during central venous cannulation in children may be an initial hindrance. Avoiding compression of small veins by the ultrasound probe in real time requires experience. It is interesting that experienced anesthesiologists needed a longer duration to learn ultrasound guidance and were less successful compared with less experienced anesthesiologists.

Because of the barriers associated with the use of ultrasound-guided techniques, our institution used alternative methods for obtaining central venous access. At our institution, the first-line method for establishing central venous access in infants has been venography because we did not have extensive experience using ultrasound-guided methods. As shown in a previous study, however, the success rate for venography was 95.8%, which was significantly lower than that for ultrasound-guided methods (99.6%). In the present cohort study, the success rate for the venography guidance technique was 100%, which was higher than rates in the previous report. Based on our success rate, venography seemed to be an acceptable method for obtaining central venous access in our neonate and infant patients. Conversely, the incidence of complications associated with venography at our institute was 20%. This rate was higher than that in the previous report (0.75%). However, it is important to note that no patients in our study experienced hematoma or arterial puncture using this method; all complications involved obstructions of the intravenous peripheral venous catheter, thereby requiring additional intravenous catheters to be inserted.

To the best of our knowledge, this is the first report on arterial injection venous return guidance for inserting central venous catheters. When arterial injection venous return guidance was first introduced, there were no viable alternatives for obtaining central venous access. In this cohort, all patients were hemodynamically unstable at intervention with various venous catheters placed to administer inotropic drugs. Therefore, we could not insert an additional intravenous catheter in the lower extremity only for venography. We hesitated to use ultrasound guidance because we had little experience with the method. A 24-gauge cannula was coincidently placed in the peripheral artery of the lower extremity to monitor hemodynamics in the infant. We thought of performing venography in the return phase of angiography. Despite concerns about the effect of the contrast used in arterial injection venous return guidance, we found that it was sufficient for guidance during femoral venous cannulation. Compared with venography, arterial injection venous return guidance showed no significant differences in time of injection, total time, or overall success rate. Based on these findings, arterial injection venous return guidance technique could be used as safely and effectively as venography guidance.

Limitations of our study include the relatively small sample size, which limited detailed statistical analysis. Ideally, a prospective single-blinded study on a large group would be useful to substantiate the findings of our retrospective study.

Conclusion

Arterial injection venous return guidance was found to be as safe and efficient as venography in establishing central venous access. This new technique is a viable alternative when other options are not available.

Disclosure Statement

None.

Author Contributions

Study conception: MK and HE
Data collection: HE and MK
Analysis: HE
Investigation: HE and MK
Writing: HE
Funding acquisition: none
Critical review and revision: all authors
Final approval of the article: all authors
Accountability for all aspects of the work: all authors

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