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Ultrasonography-guided central venous port placement with subclavian vein access in pediatric oncology patients

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ABSTRACT

Background/Purpose: To evaluate the technical success and complications of image-guided central venous port (CVP) placement with subclavian vein (SCV) access in pediatric oncology population.
Materials and methods: Ninety-two children (52 boys, 40 girls; mean age, 8.5 years) underwent CVP implantation under local anesthesia with conscious sedation. SCV access was firstly attempted under ultrasonographic guidance and CVP implantation was performed under fluoroscopic guidance. Technical success, peri-procedural (<24 h) complication, and post-procedural (>24 h) complication were assessed.
Results: In total, 102 CVPs were implanted in 92 children with a mean catheter time of 364 days (total, 38,224 days; range, 14–1911 days). In three small children, conversion of SCV access to internal jugular vein access yielded a primary technical success rate of 97.1% and overall technical success rate of 100%. Three minor peri-procedural complications were observed (2.9%) and seven post-procedural infectious complications occurred (infection rate, 6.7%; 0.18/1000 catheter days). No pneumothorax, catheter malposition, venous thrombosis, or mortality occurred.
Conclusion: Image-guided CVP placement with SCV access in a pediatric population was performed with high technical success and low complication rate without general anesthesia. This procedure can be taken into account as a choice of procedure when internal jugular venous access is not possible.

Reliable access to the central venous system is essential for the management of oncologic patients who require frequent blood products, chemotherapy, and other intravenous medications. Placement of a central venous port (CVP) using local anesthesia and real-time ultrasonographic (US) and fluoroscopic guidance has been widely accepted since it was first reported by Morris et al. [1]. Image guided CVP placement via internal jugular vein (IJV) has a higher rate of technical success and facilitates better patient comfort during installation than surgical placement using a landmark technique in adult population [2–4]. Recent developments of high-resolution transducer equipped with US and micropuncture technique using 21-gauge needle contribute to high success and low complication of CVP placement with IJV access even in pediatric population [5–9].

Subclavian vein (SCV) access has been thought to have a higher rate of peri-procedural (e.g. pneumothorax) and post-procedural complications (e.g. venous thrombosis, or pinch-off syndrome) than IJV access. However, recent studies suggest that CVP placement with SCV access in adult population is acceptable with high technical success and limited number of complications [10–14]. On the other hand, SCV access is challenging and has been little applied in pediatric population because of technical difficulties associated with smaller vessel diameter, variation in body size, and poorer patient tolerance [15,16]. No previous studies have evaluated image-guided CVP placement with SCV access in pediatric population.

The purpose of the present study was to evaluate the technical success and complications of image-guided CVP placement with subclavian vein access in pediatric oncology population.

1. Materials and methods

1.1. Study population

This retrospective study was conducted in accordance with the revised Helsinki Declaration, and institutional review board approval was obtained. Between April 2006 and March 2012, we performed 102 consecutive CVP implantations in 92 children. During the period between April 2005 and March 2012, the SCV was the preferred means of access at our institution because operators had considerable experience in CVP placement via the SCV. From April 2012, however, our preference changed to IJV access because of its relative ease and safe of access, and SCV access was employed only when the IJV cannot be used for central venous access. The patient population included 52 boys and 40 girls

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with a mean age of 8.4 years (range, 6 months to 15 years). The distribution of children's age was summarized in Table 1.

All of these patients had malignant disease requiring chemotherapy, and the primary cancers were as follows: rhabdomyosarcoma (n = 18), osteosarcoma (n = 18), retinoblastoma (n = 13), neuroblastoma (n = 12), lymphoma (n = 9), Ewing sarcoma (n = 8), leukemia (n = 7), ependymoma (n = 2), medulloblastoma (n = 2), pancreatoblastoma (n = 2), ovarian cancer (n = 1), and colon cancer (n = 1).

1.2. CVP implantation technique

Written informed consent was obtained from patients and/or parents of the patients before all procedures. Antibiotic prophylaxis with cefazolin sodium, at a dose titrated to the patient's body weight, was administered intravenously 30 min before the procedure in all cases. Patients with a prolonged prothrombin time (International Normalized Ratio > 1.5) and platelet count of $<50{,}000/mm^3$ received blood products before the procedure to correct the deficiencies.

The CVP was routinely implanted through the SCV access, because it does not require incision at the neck which may be an advantage for cosmetic reason especially in young populations and operators had sufficient experiences in SCV access.

All of the procedures were performed by five experienced operators on X-ray fluoroscopy tables equipped with a portable US device, as reported previously [10], and micropuncture technique (Micropuncture kit; Cook Inc., Bloomington, Indiana, USA) was used when venipuncture using an 18-gauge needle was thought to be inappropriate by operators. All the procedures were performed on an inpatient basis under local anesthesia with 1% lidocaine. A peripheral intravenous catheter was inserted in all patients, who were monitored using electrocardiography, pulse oximetry and non-invasive blood pressure cuffs. Conscious sedation was preferred in all patients, because non-anesthesiologists can apply it outside the operating room. Conscious sedation was induced intravenously by pediatrician using thiamylal sodium (Kyorin-seiyaku, Tokyo, Japan) at a loading dose of 3 mg/kg, with a supplementary dose of 1 mg/kg if the patient showed agitation or expressed complaint. Ketamine hydrochloride (Daiichi-sankyo, Tokyo, Japan) was also administered intravenously at the standard dose of 0.5 mg/kg just before thiamylal injection in 29 patients according to the pediatrician's preference. General anesthesia was not performed and no laryngeal mask airway or endotracheal intubation was employed in any of the patients.

Venous access was performed under real-time US guidance with infraclaviclar approach as described in previous study [16]. We used 10-MHz linear hockey stick probe (Sonosite Titan; Bothell, WA, USA). The probe was positioned over or just below the clavicle to visualize the distal part of the SCV in the infraclavicular area. Then, the probe was tilted cranially a little in order to obtain the best longitudinal image of the distal SCV, the clavicle, and the proximal SCV. For younger children, the probe was tilted to be able to expose the needle entry site. The SCV was punctured with an in-plane approach, maintaining the longitudinal view of the SCV. We changed venous access site from the SCV to the IJV if puncture failed after more than three attempts, or if venous access had to be abandoned because of hematoma development at the puncture site.

After the puncture of the SCV, real-time fluoroscopy was used for guidance of the wire, dilator and catheter manipulations. A 0.018-inch guidewire was inserted into the vein through the needle and advanced to the proximal right atrium. Then, a 4-French coaxial dilator was inserted. The 0.018-inch guidewire and the inner dilator were then removed and replaced with a 0.035-inch J-shaped guidewire from the catheter kit. The outer dilator was removed and exchanged for a peel-away sheath supplied with the catheter kit. An indwelling catheter was advanced over the wire to the junction of the right atrium and superior vena cava, and the peel-away sheath was then removed.

A subcutaneous pocket for a port reservoir was created by blunt dissection on the anterior chest wall approximately 2 cm caudal to the clavicle using a 2–3-cm incision. The subcutaneous tunnel for the indwelling catheter was created from the venous access site to the pocket in a gentle curve and connected to the port. The port was implanted into the pocket and the skin and venous access site incision was secured with running subcuticular sutures using resorbable 3-0 vicryl and steristrips. After the procedure, the positions of the catheter tip and port, and catheter curve at the venous puncture site were evaluated using fluoroscopy (Fig. 1). Patients were transferred accompanied by a medical team including the pediatricians. The presence of pneumothorax and the position of catheter tip were monitored by chest radiograph one day after the procedure. A 24-gauge Huber point needle was used for infusion. If the CVP was not used for a long period, it was flushed with 10 ml of saline solution at least once every four weeks by the pediatricians or a nurse. The patients were asked to report back to the interventional radiology department as soon as possible if malfunction or infection of the CVP became evident [17].

The CVP system comprised a 5-French (n = 50) or 6-French (n = 52) Anthron PU catheter (Toray Medical, Tokyo) and a CELSITE port (Babyport or Smallport; B. Braun Medical Inc., Bethlehem, PA, USA) (Fig. 2). The size of the port reservoir and the indwelling catheter was selected according to the body size of the patient.

1.3. Study endpoints and definition

Technical success and complications were assessed, and all complications arising after CVP placement were reviewed on the basis of information obtained from the referring physician and medical records. Primary technical success was defined as insertion of the indwelling

Table 1
Patient population and age distribution of patients (n = 92).

Parameter	Value
Patient population	
Mean ± SD	8.4 ± 4.2
Range	6 months–15 years
Sex (boy:girl)	52:43
Distribution by age group	
Infants (birth to one year)	2
Toddlers (one to three years)	13
Preschool children (four and five years)	17
School children (six to eleven years)	32
Adolescents (twelve to 15 years)	31

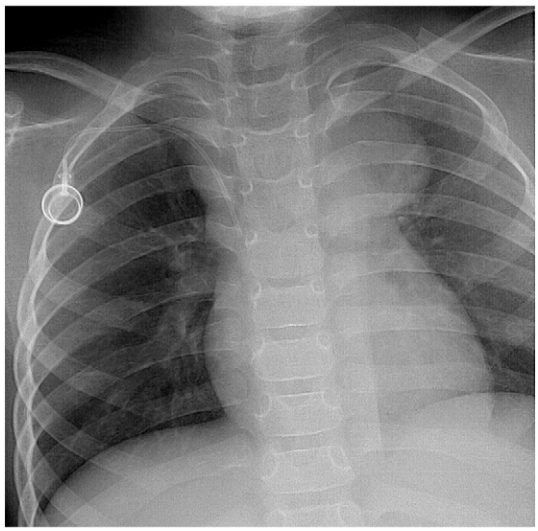

Fig. 1. Chest radiograph after central venous port implantation via the right subclavian vein in a six-year-old boy shows tip of the catheter at the superior vena cava and right atrial junction.