BRIEF REPORT

Use of Vascular Ports for Long-Term Apheresis in Children

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ABSTRACT

High-flow ports have been used for apheresis in adults. The purpose of this study was to demonstrate the efficacy of ports for apheresis in children and to survey satisfaction of patients and their families with their use. A retrospective review of clinical details was combined with a prospective assessment of the experience of patients and their families. Eight patients (mean age, 10.4 y; mean weight, 35 kg) had nine ports placed for long-term apheresis. All 246 treatment sessions were completed successfully. Access difficulties occurred in eight of 246 sessions (3%). Alarms occurred in 40 of 246 sessions (16%), resulting in delays in 10 of 246 sessions (4%). A survey of early experience indicated overall satisfaction with and a preference for ports for apheresis.

Apheresis is a procedure in which a patient's whole blood is circulated through a machine, a specific component is selectively cleared or modified, and the blood is returned to the patient along with donor blood if necessary (1). The targeted component (eg, red or white blood cells, plasma, antibodies, cholesterol) and frequency of apheresis depend on the patient's underlying condition (1). Published experience in children is limited (1). Adequate vascular access is critical, and the device used must be capable of high flow rates as required by the apheresis machines (2). Long-term apheresis in adults is traditionally provided through large-bore, thin-walled, double-lumen, external tunneled central venous lines or by arteriovenous fistula (2). Challenges of maintaining long-term, intermittent apheresis through external lines are well recognized (3). New designs of subcutaneous implanted ports can tolerate the high flows required for apheresis and have been used in adults (4). Advantages of implanted devices over external lines include improved quality of life and reduced infection rate (5); disadvantages include painful, large-bore needle puncture of the reservoir for each treatment. The purpose of this study was to examine treatment efficacy, complications, and experience of families among our first pediatric patients undergoing long-term apheresis through a high-flow implanted port.

MATERIALS AND METHODS

Institutional review board approval was obtained. Individual parent consent for the survey was also obtained. This was a retrospective study of a preliminary group of patients who underwent long-term apheresis through a high-flow port between March 2009 and February 2014. Patients were identified and clinical data were obtained through the radiology information system, interventional radiology database, electronic patient chart, picture archiving and communication system, and Apheresis Unit records. Details included demographics, diagnosis, outcomes, and apheresis parameters (medications given before apheresis, anxiety issues, blood priming, vital signs, flow rates, procedural alarms, and complications). Family acceptance and satisfaction with the port were prospectively surveyed from a questionnaire using a 5-point Likert scale (**Tables E1, E2**, available online at *www.jvir.org*).

Each port placed was counted as a new device. Each apheresis treatment session was counted individually. Technically successful treatment was defined as the ability to complete the apheresis treatment session with the desired flow rates and without complications. Functional success of apheresis was defined in accordance with the literature as follows: (*a*) clearance of sickled hemoglobin (hemoglobin S) concentration to $< 30\%$ for patients with sickle cell disease (6), (*b*) clinical improvement for graft-versus-host disease based on symptomatic scoring of different organ systems (7), and (*c*) reduction in total or low-density lipoprotein

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cholesterol concentration by 65%–70% for familial hypercholesterolemia (8). Complications were graded according to Society of Interventional Radiology (SIR) guidelines (9).

All children had high-flow ports (Vortex; AngioDynamics, Latham, New York) placed under general anesthesia and sterile conditions, using ultrasound and fluoroscopic guidance with standard interventional radiology technique and with port fixation to the anterior chest wall in the subcutaneous pocket (10). Ports were either heparinized or left accessed for same-day treatment. Most were double-lumen ports for continuous efferent and afferent flow. Apheresis sometimes can be managed by a single-lumen port by sequential blood withdrawal, modification, and return infusion through the port or a peripheral intravenous line (3).

Port sites were treated with topical anesthetic cream (EMLA; AstraZeneca, London, United Kingdom) for $\geq$ 1 hour before access, with or without vapocoolant spray (Pain Ease; Gebauer Company, Cleveland, Ohio) administered immediately prior. Ports were accessed under sterile conditions in the Apheresis Unit with straight, large-bore 16-gauge high-flow needles (AngioDynamics) in each chamber. If the required flow rate was $\leq$ 35 mL/min, only one 16-gauge needle was used for aspiration, and a 20-gauge needle was used for return flow, alternating chamber sides at each session to prolong the integrity of the port's septum (3). Port reservoirs were heparin locked at the end of the session.

RESULTS

Nine high-flow ports were placed in eight patients (three boys and five girls) ranging in age from 3.8 to 15.2 years (mean age, 10 y) and weighing 13.1–49 kg (mean weight, 35 kg). Indications included chronic graft-versus-host disease (n = 5) for photopheresis every other week, sickle cell disease (n = 2) for monthly red cell exchange, and familial hypercholesterolemia (n = 1) for lipopheresis every other week increasing to weekly. Ports were placed in the internal jugular vein (right, n = 7; left, n = 2). There were seven double-lumen ports and two single-lumen ports. One single-lumen port was placed in an outside institution. The **Table** presents apheresis inlet flows as required by the apheresis equipment, the actual flows averaged in the study patients, and the percentage of sessions with adequate flows.

At the time of review, the total number of apheresis treatments performed was 246 (median, 21 sessions per port). All 246 sessions were technically successful and well tolerated without complications, without alarms in 206 of 246 sessions (84%) and with alarms in 40 of 246 sessions (16%). Alarms contributed to delays in 10 of 246 sessions (4%), with a mean of 1.4 hours in sessions delayed, or an average of 17 minutes per session with an alarm. Alarms were managed by combinations of saline flushing (n = 27), needle repositioning or reversal (n = 12), or tissue plasminogen activator instillation (n = 5). Access difficulties occurred on eight (3%) occasions. Apheresis sessions were deemed functionally successful in seven of eight patients (**Figs 1, 2**). One patient died of end-stage graft-versus-host disease with a functioning port after only six treatments, 145 days after port placement, which had been placed very late in her disease course.

The median port dwell time was 371 days (range, 36–913 d). There were no complications during the procedure. There was one line infection (0.025 per 100 line days). This recurrent *Staphylococcus epidermidis* infection occurred late and required port removal at 792 days when a pocket infection occurred (SIR D). A second port was inserted 2.5 weeks later. There were seven early minor complications (SIR A), including oozing after access needle removal (n = 5/246) and bruising at the access site (n = 2/246). The youngest patient (age 3 y) had marked anxiety with needle access, so oral analgesia and anxiolytics were given before each session.

The satisfaction survey was completed by seven of eight patients (one patient died) and five of eight parents, including the parent of the patient who died (**Tables E1, E2**, available online at *www.jvir.org*). All eight patients had previous experience of an external central venous line

Table. Apheresis Inlet Flows Required by Apheresis Equipment and Flows Averaged in Study Patients

Patient No.	Diagnosis/Treatment	Weight (kg)	Port Placed	Flows Required	Flows Averaged	Flow Range	Adequacy of Flows (%)
1	FHC/lipopheresis	13.1	DL	18 mL/min (1 × kg)	22 mL/min	7–71 mL/min	82
		17.6	DL		27 mL/min	9–119 mL/min	97
2	SCD/red cell exchange	40.8	DL	40 mL/min (1 × kg)	46 mL/min	20–60 mL/min	100
3	GVHD/photopheresis	29.5	SL	Maximum 25 mL/min	21 mL/min	0–50 mL/min	94
4	GVHD/photopheresis	45.6	DL	Maximum 25 mL/min	13 mL/min	0–20 mL/min	84
5	GVHD/photopheresis	37.6	DL	Maximum 25 mL/min	17 mL/min	0–50 mL/min	88
6	GVHD/photopheresis	49	DL	Maximum 25 mL/min	16 mL/min	0–46 mL/min	90
7	SCD/red cell exchange	30.6	DL	30 mL/min (1 × kg)	36 mL/min	20–40 mL/min	100
8	GVHD/photopheresis	48.5	SL	Maximum 25 mL/min	19 mL/min	14–40 mL/min	100

DL = double-lumen, FHC = familial hypercholesterolemia, GVHD = graft-versus-host disease, SCD = sickle cell disease, SL = single-lumen used for photopheresis on specific XTS machine.