CLINICAL STUDY

Initial Clinical Experience: Symmetric-Tip Dialysis Catheter with Helical Flow Characteristics Improves Patient Outcomes

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ABSTRACT

Purpose: To report preliminary clinical experience with a new symmetric-tip dialysis catheter compared with a conventional split-tip catheter.

Materials and Methods: Over a 5-month period, patients requiring a tunneled catheter for hemodialysis or undergoing exchange of a dysfunctional dialysis catheter at a tertiary academic medical center were retrospectively analyzed. Patients underwent placement of a VectorFlow or Ash Split Cath catheter at the discretion of the inserting interventional radiologist. Patient demographics, catheter patency, mean blood flow rate, and arterial and venous pressures were compared according to catheter type. Catheter failure was analyzed based on clinical and anatomic variables by using a multivariate Cox proportional-hazards model.

Results: A total of 33 VectorFlow and 46 Ash Split Cath catheters were placed. Patients in the VectorFlow group had significantly higher body mass index ($P = .013$) and Charlson Comorbidity Index ($P = .049$), as well as more non–internal jugular vein placements. At 120 days, 89% of VectorFlow catheters remained functional, compared with 45% of Ash Split Cath catheters ($P = .046$). The VectorFlow catheter was associated with 16% lower arterial pressures during dialysis ($P = .009$); mean blood flow rate was equivalent. On multivariate analysis, the risk of catheter failure was 13.3 times higher in the Ash Split Cath group compared with the VectorFlow group ($P = .004$). Left-sided catheters were also predictive of catheter failure (relative risk = 5.5; $P = .02$).

Conclusions: The VectorFlow catheter was associated with a significant increase in intervention-free catheter patency compared with the Ash Split Cath catheter, with equivalent flow at lower arterial pressures during dialysis.

ABBREVIATIONS

BMI = body mass index, CCI = Charlson Comorbidity Index, Qb = blood flow rate

During the high-flow conditions experienced during hemodialysis, fluid dynamics intrinsic to specific catheter configurations has implications for catheter thrombosis and dialysis adequacy (1,2). Between dialysis sessions, retention of catheter locking solutions can affect catheter patency and even all-cause mortality (3). Commercially available catheter tip designs have usually included step-tip and split-tip configurations. In the past decade, symmetric-tip catheters have become widely used alternatives to these conventional configurations because of their ease of placement and the evidence of decreased recirculation during reversal of the arterial and venous lumens during dialysis (4–6). In late 2014, the VectorFlow catheter (Teleflex, Wayne, Pennsylvania; Fig 1), a new symmetric-tip catheter, was approved by the US Food and Drug Administration. This catheter was developed with

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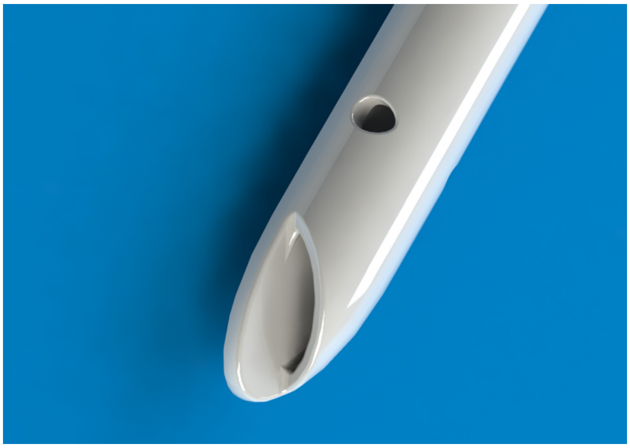

Figure 1. VectorFlow catheter. The terminal lumens are helical to deflect blood flow to produce a gradual transition of blood velocities and trajectories as fluid enters and leaves the device and to minimize recirculation.

the goal of improving catheter performance by optimizing fluid dynamics through helical flow-deflecting interfaces at the catheter tip. This tip design is intended to reduce platelet activation while minimizing recirculation (7,8). Initial clinical experience with this catheter was compared with a conventional split-tip device, the Ash Split Cath catheter (Medcomp, Harleysville, Pennsylvania), in the present retrospective analysis.

MATERIALS AND METHODS

Institutional review board approval was obtained for this retrospective study, which was performed in compliance with the Health Insurance Portability and Accountability Act. Over a 5-month period, 63 patients were identified from a prospective quality-assurance database (Hi-IQ; ConexSys, Lincoln, Rhode Island) who underwent placement of 79 tunneled hemodialysis catheters. During this period, our practice began placement of the Arrow–Clark VectorFlow catheter in patients considered to be at high risk for tunneled catheter failure by the inserting interventional radiologist. Although no formal criteria were used in designating patients in whom the new catheter would be placed, in general, the device tended to be placed in individuals at higher risk for tunneled catheter failure (eg, cases of morbid obesity, requirement for a femoral tunneled catheter, or recent partial surgical thrombectomy of right atrial thrombus) or in patients who presented with a failed Ash Split Cath catheter as a result of thrombosis, poor flow, or bacteremia requiring guide wire exchange. Patients deemed to be at low risk continued to undergo placement or exchange of conventional Ash Split Cath catheters. Tunneled catheter removal and placement of new tunneled dialysis catheters at a later date were considered as independent events.

All catheters were placed in the interventional radiology suite under ultrasound and fluoroscopic guidance by or under the direction of experienced, fellowship-trained operators. Most catheters were placed from a right or left internal jugular approach; when the internal jugular veins were occluded, an external jugular vein was used for insertion. In a subset of patients with bilateral central venous occlusion, tunneled femoral catheters were placed. Preprocedural antibiotic therapy was not administered for de novo catheter placement but was administered for patients undergoing catheter exchange. All skin surfaces were prepared with a 2% chlorhexidine solution and allowed to dry before puncture. Catheters were placed by conventional antegrade radiologic technique with the use of peel-away sheaths with aerostatic valves. Catheter tips were positioned in the midportion of the right atrium for the VectorFlow catheter and in the middle to lower third of the right atrium for the venous tip of the Ash Split Cath catheter. Venotomy incisions were closed with a single absorbable suture and/or tissue adhesive. Catheters were locked with a 100-U/mL solution of heparin or a needleless barrier cap not requiring heparin (Tego cap; ICU Medical, San Clemente, California).

Catheter patency was defined in accordance with the recommended reporting standards of the Society of Interventional Radiology (9) with the exception of catheter insertions performed during guide wire exchanges; these catheter exchanges were analyzed combined with de novo insertions. Catheter failure was the result of infection, thrombosis, or both. Catheter patency was censored (ie, removed from subsequent patency calculations) at the last dialysis session before recovery of renal function, death, discontinuation of hemodialysis as a result of initiation of peritoneal dialysis, or, most commonly, catheter removal for a functioning vascular access. Catheter function was measured by blood flow rate (Qb), arterial port pressure, venous port pressure, and duration of dialysis session. Inpatient dialysis treatments were performed by using Fresenius 2008K and 2008K-2 dialysis machines (Fresenius Medical Care, Waltham, Massachusetts). Initial postinsertion and final dialysis session parameters were obtained from dialysis facility data. For patients initiating hemodialysis, in whom the target Qb of 400 mL/min was attempted in a stepwise fashion after two or three sessions of hemodialysis starting at 200 mL/min, the third or fourth dialysis session (ie, the first intended to run at a Qb of 400 mL/min) was designated as the initial dialysis session. For patients undergoing exchange of a dysfunctional dialysis catheter, the next dialysis session was considered as the initial dialysis session with the new catheter with resumption of target Qb. Catheter insertions were also considered as independent events; a particular patient could have undergone exchange of one type of catheter and insertion/exchange of another catheter type during the study period according to the discretion of the inserting physician.

Intergroup comparisons of continuous variables of patient demographics were compared with two-sample