A Single-Institution Study of Permanent Vascular Access Outcomes in Patients undergoing Hemodialysis

Cameron E. Alexander, MD, BSc
The School of Medicine and Dentistry, University of Aberdeen, Aberdeen, United Kingdom
Bernhard Wolf, MD
Vascular Unit, Raigmore Hospital, Inverness, United Kingdom
Nicola Joss, MD
Raigmore Renal Unit, Raigmore Hospital, Inverness, United Kingdom

Abstract

Background: *Vascular access (VA) is essential for successful hemodialysis (HD) but its provision poses significant challenges to renal services. This study aimed to report the long-term outcomes for different types of first permanent VA, and identify factors that affected outcomes in a cohort of patients undergoing HD at a single renal unit.*

Methods: *Data recorded before April 1, 2013, were collected on factors related to patient characteristics and VA management. Univariate analysis of VA survival was undertaken using the Kaplan-Meier method with log-rank testing used to test for differences between subgroups. Secondary outcomes included VA complication and intervention rates.*

Results: *Of those first permanent VA attempts ($n = 103$), 26.2% were radiocephalic arteriovenous fistulae (RCAVF), 54.4% were brachiocephalic arteriovenous fistulae (BCAVF), 10.7% were transposed basilic arteriovenous fistulae (TBAVF), and the remaining 8.7% were polytetrafluoroethylene forearm loop arteriovenous grafts (AVG). Overall cumulative secondary VA survival rates at 6, 12, and 24 months were 90.9%, 82.8%, and 73.4%, respectively. Complication rates for RCAVF, BCAVF, TBAVF, and AVG were 0.5, 1.2, 4.5, and 2.6 per patient year on HD, respectively. Intervention rates for RCAVF, BCAVF, TBAVF, and AVG were 0.4, 0.8, 2.9, and 2.1 per patient year on HD, respectively. A primary renal diagnosis of diabetes ($P = 0.022$), use of temporary central venous catheter ($P = 0.003$) or rope-ladder needling ($P = 0.013$), and the use of TBAVF or AVG ($P < 0.001$) were predictive of significantly poorer VA survival.*

Conclusions: *RCAVF and BCAVF were associated with significantly superior outcomes compared with TBAVF and AVG in terms of complication and intervention rates, and long-term survival.*

Keywords: *arteriovenous fistula, hemodialysis, vascular grafting, vascular patency*

Introduction

The provision of effective vascular access (VA) is fundamental for successful hemodialysis (HD) but its delivery continues to pose significant challenges for renal services.[1] Current guidelines advocate the use of the arteriovenous fistula (AVF) as first line for permanent VA for HD, ahead of arteriovenous grafts (AVG) and venous catheters, because it is associated with superior durability and complication rates, and because of the need to use distal vessels in the arm to preserve future VA sites should they be required.[1] Despite this, approximately one-third of AVFs will have failed 2 years after creation, and 28%-53% never achieve adequate blood flow to be used for HD.[2,3] Furthermore, VA complications are reported to account for 17%-30% of all hospital admissions in HD patients.[4] As patient survival on HD continues to improve, and the HD population increases in

Correspondence concerning this article should be addressed to cameron.alexander.09@aberdeen.ac.uk
http://dx.doi.org/10.1016/j.java.2016.12.004

age and comorbidity, poor VA outcomes will become an increasingly demanding obstacle to the delivery of HD care.[5,6] The development of VA guidelines has provided the platform by which standardized care can be delivered, but they are limited by the availability of reliable evidence examining long-term, clinically important VA outcomes in modern HD populations.[1,7] Most fundamentally, improvements in VA delivery are restricted by a limited understanding of those factors that predict poor VA outcomes. The objective of this study was to report the long-term outcomes for different types of permanent VA, and to identify those factors related to patient characteristics and VA management that influenced VA outcomes in a cohort of HD patients within a single renal unit.

Methods

In this retrospective, observational study, patients who started HD at our institution or surrounding satellite units between January 1, 2007, and January 1, 2013, were identified through a search of the hospital's renal database, and included if they had a permanent VA created, were aged ≥18 years on starting HD, and did not recover renal function within 90 days of starting HD. Patients who had previously failed peritoneal dialysis (PD) were included, but those with a previous history of HD or renal transplantation were excluded because of their increased risk of previous failed permanent VA. Our institution is the largest provider of HD for patient populations located in the Scottish Highlands and serves a population of approximately 299,000.

Data recorded before April 1, 2013, were retrospectively collected from our institution's surgical and renal database systems on factors related to patient characteristics, patient management, and VA care. Study variables and patient subgroups were defined using classifications adopted by clinical guidelines and national renal registries.

Two vascular surgeons, with more than 10 years experience at the start of the study period, were responsible for VA creation: a radiocephalic fistula (RCAVF) with side-to-side anastomosis was first choice, followed by the brachiocephalic fistula (BCAVF), and then the transposed basilic fistula (TBAVF). A forearm loop arteriovenous graft with polytetrafluoroethylene was created only where AVF creation was not possible. Preoperative imaging of vessels was not undertaken routinely, but only when this was considered necessary following physical examination. There were no predefined minimal requirements of vessel size for VA construction. A 6-week period was allowed for AVF maturation. Buttonhole needling was used as the preferred option for AVF cannulation as of April 1, 2009, before which rope-ladder needling was routinely used. Antiplatelet or anticoagulant drugs were not prescribed with the intention of reducing VA complications, but only for other comorbidities.

A team of dialysis nurses, led by a specialist VA nurse, was responsible for VA monitoring; patients were referred for radiologic investigation when venous pressures at 0 pump flow corrected for mean arterial blood pressure were recorded as ≥ 0.50, or when transonic blood flow measurements were recorded as <500 mL/min for AVFs, <600 mL/min for AVG, or when there was a reduction of blood flow of >25% over 4 months. Multidisciplinary team meetings were held each week to discuss the most suitable method of intervention when this was not required urgently.

The primary outcomes were primary and secondary survival of the first surgically created permanent VA. Primary survival was defined as the time from VA creation to first intervention (surgical revision, angioplasty, thrombolysis, or stenting), and secondary survival as the time from creation to failure. VA failure was defined as the point at which the VA device was no longer capable of providing blood flow sufficient to obtain adequate HD (<350 mL/min) and was not salvageable by radiologic or surgical intervention. When an AVF failed to mature this was also defined as VA failure, even when the AVF had never been used for HD. Surgical revision of VA was distinguished from the creation of a new VA, with the latter requiring a change in the type or anatomic location of the VA. Secondary outcomes included VA complication and intervention rates. Data for VA-related bacteraemia could not be recorded for the first permanent VA because it was not possible to differentiate such cases from those that occurred with a temporary central venous catheter (CVC) in situ.

Differences between subgroups were tested for using the Student t test for normally distributed variables, Mann-Whitney U test for those with skewed distribution, and χ^2 test for categorical variables. Univariate analysis of primary and secondary VA survival was undertaken using Kaplan-Meier survival analysis, with the date of first intervention or VA failure used as respective end points. Patients were censored where they died, stopped HD or changed to a different treatment modality, were transferred to a different institution or lost to follow-up, or on the final observation date (April 1, 2013). Log rank testing was used to test for differences between subgroups with $P < 0.05$ considered statistically significant. All statistical analyses were performed using SPSS software (version 21.0; IBM-SPPS Inc, Armonk, NY). Ethical approval was given for the use of patient medical records from the local UK National Health Service Research and Development department.

Results

An electronic search identified 128 patients starting HD at our institution between January 1, 2007, and January 1, 2013; of these, 15 patients were excluded (9 had failed renal transplants, 3 never had permanent VA created, 2 had previously undergone HD, and 1 recovered renal function within 90 days of starting HD), and the remaining 103 were included. Table 1 describes the characteristics of the included cohort. During the period of study, 12.6% (n = 13) of included patients underwent renal transplantation, 1.0% (n = 1) switched from HD to PD, 2.9% (n = 3) of patients were transferred to a different renal unit, and 38.8% (n = 40) of patients died. There were no VA-related causes of death.

On the date of starting HD, 45.6% (n = 47) of included patients started HD with a temporary CVC, and 54.4% (n = 56)