Investigation

Comparison of Procedure Cost for Thrombectomy of Arteriovenous Fistulas and Grafts

Donald Schon,*† Tammy DeLozier,† and Nina Patel‡

*Arizona Kidney Disease and Hypertension Center, Phoenix, Arizona, †Private Practice, Montebello, California, and ‡The University of Arizona Health Science Center, Tucson, Arizona

ABSTRACT

Expenditures on dialysis vascular access now exceed $2.5 billion annually in the US. Studies suggest that significant savings could be achieved by increasing arteriovenous fistula (AVF) prevalence to > 65%. It is common but unsubstantiated opinion that AVF have lower maintenance costs than arteriovenous grafts (AVG). This manuscript tests this hypothesis by direct comparison. Equipment utilization time and supply utilization on 110 thrombectomy procedures on AVF and 258 on AVG were compared. Procedures techniques were standardized within one facility and procedures performed by a multiple but limited number of operators. There were no significant differences in demographic variables and comorbid factors between groups. Time to complete AVF thrombectomy was 1.7 times that for AVG. In addition, major supplies used such as wires and balloons were also significantly greater. Interventionists who took longer than average to thrombectomize AVF took longer than average to thrombectomize AVG. The prevalence of arterial inflow lesions was 1.5 greater in thrombosed AVF versus Thrombosed AVG. Procedure costs when analyzed in terms of procedure time, room utilization, staff, and equipment are significantly greater for thrombosed AVF than thrombosed AVG.

Introduction

End-Stage Renal Disease (ESRD) expenditure data demonstrate that 1.5% of Medicare recipients with ESRD expend 5.9% of all Medicare dollars (1). While there are many contributing factors, expenditures on dialysis vascular access contribute $2.5 billion annually to ESRD patient costs (2). An excessive prevalence of dialysis catheters and arteriovenous grafts (AVG) account for a significant amount of this total expenditure (3–16).

Studies looking at ESRD populations on a cohort basis and an annual one have suggested significant savings could be achieved by an increased utilization of arteriovenous fistulas (AVF) which cost less to create, last longer, require fewer maintenance procedures, and are associated with a lower mortality and hospitalization rate (17–20). To achieve this end the Centers for Medicare and Medicaid Services (CMS) launched the National Vascular Access Improvement Initiative (NVIAI), now known as Fistula First (FF) and the National Kidney Foundation, the Dialysis Outcome Quality Initiative (KDOQI) (21,22). The FF and KDOQI have set a goal of > 65% AVF prevalence in hemodialysis patients in the US. Although not yet achieved, significant progress toward this goal has been accomplished (1).

Although demonstrably superior, AVF are not free of problems and it will be necessary to support a strategy of AVF maintenance and salvage to achieve and sustain the FF goals. Published studies suggest that procedures on AVF require more time and supplies than those performed upon AVG (23). To the extent this is accurate it suggests that although AVF have fewer problems, higher individual procedure expense could erode or eliminate savings.

The current study was designed to compare the expense of a single type of salvage procedure between AVF and AVG. The procedure chosen was access thrombectomy. This procedure is recognized to be the most difficult and costly procedure commonly performed on both types of access both in terms of interventional physician perception and RVU value. A single facility specializing in dialysis access procedures was chosen to control for variations in procedure technique and supply access. Procedures performed by multiple interventional physicians are analyzed, however, to compare variations in procedure time and utilization of staff, equipment and supplies.

Methods

The AKDHC Surgery Center is a facility dedicated to the creation, maintenance, and repair of all forms of
dialysis access and is operated as a freestanding outpatient facility. Procedures were performed by seven trained interventional nephrologists all certified in endovascular procedures by the American Society of Diagnostic and Interventional Nephrology (ASDIN). Trainees under the direct supervision of an ASDIN-certified attending performed a minority of procedures.

All procedures identified by CPT code 36870 (thrombectomy of a dialysis access) were retrospectively reviewed for a 5-year period (2003 through 2008). Procedures were included in this study only if they had radiologic documentation of thrombosis and were technically successful in establishing flow by the end of the procedure. Recurrent procedures in the same patient were analyzed separately. Cost was evaluated in terms of procedure time and supply utilization. A preliminary review of the data demonstrated marked variability when including procedures performed by inexperienced physicians. Therefore, data by interventionalists performing fewer than five procedures was eliminated. A comparison of patient billing records, facility procedure logs, and medical records insured that all eligible cases occurring during this study period were captured for analysis.

AVF thrombectomies were performed by techniques previously published (24,25). In summary, the AVF procedure involved pharmomechanical removal of thrombus accomplished with a combination of small dose of thromboplastin activating factor (tPA) FDA approved for clot dissolution, heparin and balloon angioplasty. Stenotic lesions identified were angioplastied if deemed to narrow the lumen by greater than 50% compared with the adjacent normal artery or vein and deemed to be flow restricting. Clot removal and angioplasty success were determined roentgenographically. No mechanical thrombectomy devices were utilized during these procedures.

For AVG thrombectomies, sheaths were placed antegrade and retrograde, heparin administered, and thrombus extracted utilizing an embolectomy catheter. Flow was restored by mechanical removal of the arterial plug. As with AVF all stenotic lesions representing a >50% luminal restriction were treated with an angioplasty balloon sized to the contingent segment of normal artery or vein. No mechanical devices other than the embolectomy catheter was employed.

Supply utilization and fluoroscopy time was determined by review of physician procedure notes together with nursing notes, technical radiologic exposure records, and resupply records for each individual procedure. Total procedure time was defined as from the application of local anesthesia to the initiation of hemostasis after the removal of the second sheath.

Statistical analysis was performed using the Statistical Package for the Social Sciences (SPSS, IBM Corporation, Armonk, NY, USA) program. Means of independent groups were compared using an independent t-test. An adjusted t-test that corrects for lack of homogeneity of variances in the data was used as appropriate as per the Levene’s test for Equality. Between group effects were determined by using the Analysis of Variance (ANOVA) test. Proportions were compared using chi-squared analysis. Statistics were evaluated using a 95% confidence band and the level of significance was set at p < 0.05.

**Results**

A total of 368 thrombotic episodes in 113 patients were determined to meet the study criteria. One hundred and ten (30%) procedures were upon clotted AVF and 258 (70%) on clotted AVG. Thirty-eight (34%) patients were found to have AVF, 68 patients (60%) had AVG, and 6% both types of access (Table 1).

Table 2 demonstrates there were no significant differences between groups for type and location of access, age, and gender.

Comorbid conditions (Table 2) were not different between groups with the exception of a statistically significant higher prevalence of liver disease (p < 0.05) in patients with AVG. Age of the patient at access placement was 59 years for patients with AVF and 60 years for patients with AVG. Age of the access at the time of thrombosis was 26.8 months for patients with AVF and 27.4 months for those with AVG. Neither was found to be statistically different.

Procedure length was significantly greater for AVF, 83.8 minutes, than grafts, 48.3 minutes (Fig. 1) (p < 0.01).

However, fluoroscopy time in seconds was not different between the cohorts (p > 0.9).

Total supply usage was significantly greater for procedures upon clotted AVF than AVG (Fig. 2) and was highly statistically significant (p < 0.01).

This difference was affirmed when analyzed for wires and balloons. However, no significant difference (p > 0.05) was seen for sheaths nor stent utilization. Diagnostic catheter usage was greater for AVG (Table 3).

<p>| TABLE 1. Total number of accesses and thrombectomy procedures by access type |
|-----------------|-----------------|-----------------|</p>
<table>
<thead>
<tr>
<th>Fistulas</th>
<th>Grafts</th>
<th>Both</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total number</td>
<td>38 (34)</td>
<td>68 (60)</td>
</tr>
<tr>
<td>Total number thrombectomies</td>
<td>110 (30)</td>
<td>258 (70)</td>
</tr>
<tr>
<td>Values are expressed as N (%)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<p>| TABLE 2. Patient and access age, comorbid conditions |
|-----------------|-----------------|-----------------|-----------------|</p>
<table>
<thead>
<tr>
<th>Fistulas</th>
<th>Grafts</th>
<th>Both</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age access placement (years)</td>
<td>59</td>
<td>60</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>Age access 1st thrombectomy (months)</td>
<td>26.8</td>
<td>27.4</td>
<td>na</td>
</tr>
<tr>
<td>Co-morbid conditions, n (%)</td>
<td>CAD</td>
<td>Diabetes</td>
<td>Hypert</td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>15 (13)</td>
<td>32 (13)</td>
<td>39 (33)</td>
<td>3 (0.9)</td>
</tr>
<tr>
<td>30 (32)</td>
<td>39 (32)</td>
<td>65 (54)</td>
<td>7 (6)</td>
</tr>
<tr>
<td>2 (2)</td>
<td>4 (3)</td>
<td>7 (6)</td>
<td>na</td>
</tr>
<tr>
<td>&gt;0.05</td>
<td>&gt;0.05</td>
<td>&gt;0.05</td>
<td>&lt;0.05</td>
</tr>
</tbody>
</table>
(\(p < 0.01\)). No differences in aggregate nor individual supply utilization were apparent between accesses either at upper or lower arm locations nor in the thigh.

Prevalence of arterial lesions requiring angioplasty was significantly greater in AVF (66\%) than AVG (43\%) (\(p < 0.01\)).

Procedure time was analyzed by physician and access type (Fig. 3). Physicians performed similar percentages of procedures upon AVF and AVG.

Physicians taking longer to thrombectomize AVF also took longer to thrombectomize AVG (Fig. 4).

**Discussion**

The USRDS data document that there are currently over 368,000 Medicare dependents on dialysis in the US. Costs for access creation, maintenance, and related complications are now estimated to be greater than $3 billion annually (1,2,26). Much of this cost is felt to be related to the high prevalence in the US of dialysis catheters and grafts. Economic support for this view was provided by Schon et al. (27). These authors analyzed USRDS and DOPPS expenditures and predicted a savings of between $400 and $800 billion per cohort of patients entering dialysis if the FF goal of >65\% AVF prevalence is achieved. Eggers predicts this would translate into a savings to the Medicare system of $500 Billion on an annual basis (5).

It is generally agreed that AVFs require less maintenance than AVGs. However, it is a commonly held perception amongst interventionists dealing with dialysis vascular access that procedures on AVFs, in addition to requiring significantly more time and supplies, require significantly greater skill and entail a greater degree of difficulty than procedures on AVGs. However, very little
in a significantly greater frequency in AVF compared with AVG. This difference is important as arterial lesions requiring dilatation was significantly greater for clotted AVF than for clotted AVG. In addition, the Affordable Care Act incentivizes the formation of Accountable Care Organizations and Medical Home models. In such constructs, interventional procedures, rather than serving as a revenue source for an institution or ACO, become a cost center. Predictability of a cost basis for such models mandate accurate cost data upon which to construct performance models. It appears that unless this data includes the differential that exists between AVFs and AVGs, it will be flawed.

Fig. 4. Procedure time by physician performing greater than five declots total by access type. Dark line is fistula declots and light line is grafts.

References

5. Eggers P, Chen S: Total Medicare Expenditures for Vascular Access by Access Type. Presented at CMS Fistula First Breakthrough Initiative Stakeholder Coalition Meeting; September 16; Hunt Valley, MD, 2005

substantive data on this point exists. Coryell et al. (28) applied the reimbursement survey methodology utilized by the Relative Value Update Committee of the American Medical Association (RUC Committee) to procedures performed on AVFs and AVGs. Procedures on AVFs were found to require significantly more cognitive effort/stress than those performed on AVGs. However, their evaluation failed to demonstrate any procedure time differences. In contrast, in a large series of procedures done at multiple institutions, Beathard et al. found that thrombectomies on AVFs took significantly longer than AVGs (23). In that report, the time required for an AVF thrombectomy (n = 228) was 88.8 ± 41.8 minutes versus 51.8 ± 21.6 minutes for AVGs (n = 4671) and similar to the current study. However, these cases were done in multiple locations with different interventional physicians and with multiple techniques.

The current study examines this issue in a single institution with a controlled patient population managing dialysis access in a standardized and consistent manner. In addition, they were performed by multiple physicians of varying levels of experience but utilizing the same menu of available supplies and a uniformity of method.

The data collected reveals that the time required and the supplies expended to salvage a thrombosed AVF is significantly greater than that required for an AVG. Although this was a retrospective study, care was taken to assure that all eligible cases performed during the study period were included. The lack of difference in utilization of vascular sheaths reflected the fact that two sheaths were almost always mandated for procedures on both types of access. Stent utilization was also not different, but the number utilized was minimal.

In addition to time and supply utilization, the frequency of arterial lesions requiring dilatation was significantly greater for clotted AVF than for clotted AVG. This observation is consistent with data of Asif et al. (29). These authors found that arterial inflow lesions are found in a significantly greater frequency in AVF compared with AVG. This difference is important as arterial lesions are recognized as of greater difficulty and risk.

This study strongly suggests that the parity in RVU units for thrombectomy procedures performed upon AVFs versus AVGs should be reassessed. In addition, pay for performance parameters which are currently being developed may assume parity of cost for maintenance procedures of dialysis vascular access, regardless of type. The current study suggests the assumption upon which this will be based may be flawed.