Outcomes of Upper Arm Arteriovenous Fistulas for Maintenance Hemodialysis Access

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Hypothesis: Radiocephalic fistulas for maintenance hemodialysis access are not feasible in all patients with end-stage renal disease. Our aim was to review our experience with 3 types of upper arm arteriovenous fistula (AVF) to ascertain whether they are reasonable alternatives to radiocephalic fistulas and which, if any, have superior performance.

Patients and Methods: Patient medical records were retrospectively reviewed. The main outcomes were maturation rate, time to maturation, assisted maturation rate, complication rates, reintervention rates, primary and assisted primary patency rates, and effects of comorbidities.

Results: Eighty-six patients with end-stage renal disease underwent creation of a brachiocephalic, brachiobasilic, or brachial artery–to–median antecubital vein AVF. Overall, 80% matured, with 23% requiring an intervention to achieve maturity. The mean time to maturation was 3.8 months; 47% had a complication (inability to access, thrombosis, and so on), and 43% required additional interventions. The overall primary patency and assisted primary patency rates at 12 months were 50% and 74%, respectively. Brachiobasilic AVFs not superficialized immediately often needed a second operation. There were no significant differences in patency rates among the 3 AVF types. The AVFs in patients with diabetes took 2 months longer to mature than did those in patients without diabetes.

Conclusions: An upper arm AVF is a reasonable alternative for maintenance hemodialysis access when a radiocephalic AVF is not possible. There are 3 valid options from which to choose to best accommodate each patient’s antecubital anatomy. Diabetes may adversely affect outcomes. Our data suggest that brachiobasilic AVFs should be superficialized at the initial procedure, if feasible.

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In the United States, approximately 320000 patients had end-stage renal disease (ESRD) in 1998; 72% of these patients were treated with maintenance hemodialysis. During the past 5 years, the number of patients receiving hemodialysis has continued to increase. Placement of the radiocephalic (Brescia-Cimino) arteriovenous fistula (AVF) has been the hemodialysis access procedure of choice for patients with ESRD receiving maintenance hemodialysis because of its reliable patency, low complication rate, and preservation of alternate future access sites. However, this procedure is not always easy to perform owing to the poor quality of distal cephalic veins because of multiple prior venipunctures and cannulations. In addition, as our understanding of ESRD and skill in caring for patients with ESRD have improved, the average life expectancy of patients receiving hemodialysis has increased dramatically; many patients now outlive their first hemodialysis access site and require additional access procedures at different sites.

The increasing number of patients in whom placing radiocephalic fistulas is no longer an option has resulted in the more frequent use of prosthetic arteriovenous grafts for hemodialysis access. These grafts have been shown in multiple studies to have lower patency and higher complication rates than do native radiocephalic fistulas. Consequently, the National Kidney Foundation, New York, NY, in the Dialysis Outcomes Quality Initiative (DOQI) recently established new guidelines regarding hemodialysis access for maintenance hemodialysis and recommended that at least 50% of new hemodialysis access procedures involve the creation of a native AVF rather than placement of a prosthetic graft.

To meet this challenge, surgeons must be able to create additional sites for AVFs. Antecubital fistulas involving the brachial artery are technically feasible in many patients; veins in this area may be more resilient to repeated venipuncture. In the upper arm, 3 potential outflow veins are available—the cephalic, basilic, and median antecubital veins. Brachiobasilic...
AVFs, brachiobasilic AVFs (BB-AVF), and brachial artery-to–median antecubital vein AVFs (BMAC-AVF) have been studied individually. However, they have not been studied in parallel at 1 institution with the same outcome measurements applied to each. Therefore, the relative performance of these 3 fistulas remains unknown.

The purpose of this study was to examine our institution’s experience across 4 years with these 3 antecubital hemodialysis access procedures. Outcomes for the 3 fistulas were assessed and compared in terms of time to use, maturation rates, patency rates, and complication rates, including requirements for reintervention.

 METHODS

 DATA COLLECTION

Operating room records from the University of California, Davis Medical Center, Sacramento, Calif, from January 1999 through December 2002 were reviewed to identify all patients undergoing hemodialysis access procedures for maintenance hemodialysis. Patient medical records were then reviewed to identify those patients who underwent creation of an upper arm AVF. At our center, these include a brachioccephalic AVF, BB-AVF, or BMAC-AVF. Brachiobasilic AVFs were further subdivided into those with immediate superficialization of the basilic outflow tract and those that did not undergo superficialization of the basilic outflow at the initial operation (brachiobasilic no superficialization AVF [BBNS-AVF]). Information about patient demographics, comorbidities, and previous dialysis access procedures was collected. Follow-up data were obtained from hospital medical records and outpatient dialysis center records.

 OPERATIVE PROCEDURES

Preoperative vein mapping was not routinely performed. General or local anesthesia was used, depending on the risk of general anesthesia, as well as the preferences of the anesthesiologist, surgeon, and patient. In all cases, a transverse incision in the antecubital fossa was used to expose the brachial artery and the confluence of the cephalic and basilic veins. Anastomoses were created in an end-to-side or side-to-side fashion, depending on the mobility of the target vein. Figure 1 shows normal antecubital vascular anatomy and the 3 upper arm AVFs. For the BMAC-AVF, the median antecubital vein or a deep perforating branch was anastomosed to the brachial artery, usually resulting in a fistula with a dual venous outflow. For the BB-AVF, the basilic vein was mobilized and anastomosed to the brachial artery. Some patients were considered for immediate superficialization of the outflow vein if, intraoperatively, the outflow vein appeared to follow a deep subcutaneous or subfascial course. In these cases, the basilic vein was superficialized and transposed by creating a longitudinal incision medially up the arm and mobilizing the vein to a more superficial position. No immediate postoperative studies, such as duplex ultrasonography or radiography, were performed routinely to assess patency.

 OUTCOME MEASUREMENTS AND DEFINITIONS

The principal outcome measures were maturation rate, time to first use, assisted maturation rate, primary and assisted primary patency rates at 12-month follow-up, and rates of complications and reinterventions. Maturation was defined as successful cannulation for at least 1 complete hemodialysis session. Time to use was defined as the interval between the creation of the AVF and its maturation. Assisted maturation rate indicated that an additional intervention was required to achieve maturity. Primary patency rate was defined as the time between the initial operation and failure or the need for reintervention. Assisted primary patency rate was defined as the total life span of the AVF after the initial operation, regardless of whether reintervention was required before or after initial maturation. Secondary patency rate refers to the life span of an AVF that had become completely occluded but was successfully reopened by means of thrombectomy. Complications were inability to access because of depth (a vein with deep subcutaneous or subfascial outflow), steal, thrombosis, stenosis, primary nonmaturation, and infection. Reinterventions included superficialization of a deep outflow tract, thrombectomy, ligation of side branches, balloon fistuloplasty, and incision and drainage. Patent fistulas that did not dilate sufficiently for hemodialysis use after 12 months were considered failures to mature.

 Selected demographic factors and comorbidities were also assessed. These included age, sex, diabetes mellitus, hypertension, peripheral vascular disease (assignment of this diagnosis was based on documentation of a prior therapeutic procedure for peripheral arterial occlusive disease), history of tobacco use (at least 1 year of regular use during the past 5 years), number of previous dialysis access procedures, and length of time receiving hemodialysis before AVF creation.

 STATISTICAL ANALYSIS

The life-table method of analysis, according to the statistical formulas recommended by the Ad Hoc Committee on Reporting Standards, Society for Vascular Surgery/North American Chapter, International Society for Cardiovascular Surgery, was used to determine AVF patency rates. Kaplan-Meier analysis was used to calculate the survival rate for each AVF type. Differences in patency rates among AVF types were assessed by using the Cox-Mantel log-rank test. A Cox proportional hazards model for multivariate analysis was used to assess whether any comorbidity independently predicted a worse patency outcome. Continuous dependent variables were compared by using the unpaired t test or Mann-Whitney test, while nominal variables were compared by using the χ² test. Analysis of variance was used to assess differences in continuous outcome measurements among more than 2 independent variables. A P value less than .05 was considered to indicate statistical significance for all comparisons. Statistical analyses were performed with commercially available software (StatView for Windows version 5.01; SAS Institute Inc, Cary, NC).

 RESULTS

 PATIENTS

Eighty-six patients each underwent placement of 1 upper arm AVF during the study. Clinical characteristics of the patient population are displayed in Table 1. The most common cause of renal failure in the study population was diabetes mellitus, followed by hypertension. The mean age was 56 years, with a range of 21 to 87 years. The mean interval of receiving hemodialysis before AVF placement was 3.7 months. Only 27 of the 86 patients had undergone previous hemodialysis access procedures, meaning that the upper arm fistula was the first attempted procedure in 69% of the study population. The predominance of left-sided procedures reflects the preference for using the nondominant arm for vascular access. There were no significant differences in clinical characteristics among patients undergoing placement of the
3 types of AVF, with the exception of a higher proportion of women (8 of 9) in the BBNS-AVF group ($P = .003$).

**PROCEDURES**

Four surgeons placed all 3 types of upper arm AVF. The total number of each AVF type placed is listed in Table 2. The BMAC-AVFs were placed in increasing numbers later in the study and accounted for the differences in mean follow-up among the 3 types of upper arm AVFs (Table 2). Technical success, defined as the detection of blood flow in the venous outflow tract by means of palpation or Doppler ultrasonography, was achieved in all 86 patients at the end of the procedure.

**MATURATION, COMPLICATIONS, AND REINTERVENTIONS**

Mean ± SD follow-up was 7.2 ± 6.6 months. Table 2 shows the main outcome measurements for each type of AVF, including $P$ values for all significant end points. There were no statistically significant differences among times to first use among the AVF types. However, the BBNS-AVF showed a trend toward longer time to first use at a mean of just longer than 6 months ($P = .06$, analysis of variance). This 6-month wait was associated with the increased need for reintervention ($P = .02$) in the form of delayed basilic outflow superficialization.

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*Figure 1.* Diagram of the 3 types of upper arm arteriovenous fistula (AVF) used for hemodialysis. A, Normal anatomy of the right antecubital fossa is depicted, showing the cephalic vein (CV), median antecubital vein (MACV), basilic vein (BV), brachial artery (BA), radial artery (RA), and ulnar artery (UA). B, The brachiocephalic AVF. C, The brachiobasilic AVF. D, The brachial artery–to–median antecubital vein AVF.
Sixty-nine (80%) of all upper arm AVFs reached maturity. In 11 AVFs, failure to mature was a result of thrombosis before use. The BMAC-AVF had the highest rate of maturation at 100%. The overall assisted maturation rate was 23%. The rate of assisted maturation for the BBNS-AVF, 83%, was significantly higher than that of any other AVF (P = .009).

Although nearly half of the patients undergoing upper arm AVF placement had at least 1 complication, there were no significant differences in the overall rate of complications among the AVF types (Table 3). The most frequent complication was the inability to access the AVF, usually because of a deep subcutaneous or subfascial outflow tract. This complication occurred with the highest frequency in the BBNS-AVF group (P = .002). All AVFs requiring superficialization were unable to be accessed for hemodialysis and so, by definition, were immature. Thus, superficialization contributed to assisted maturation in all AVFs in which it was performed. The second most common complication was thrombosis before first use, which accounted for most of the failures to mature. Primary nonmaturation, when an AVF was patent but not dilated sufficiently for use in hemodialysis, occurred in 3 patients.

One patient underwent emergent exploration because of recalcitrant bleeding after needle puncture during hemodialysis. Another patient developed a large pseudoaneurysm requiring excision of the involved portion of fistula and repair. There was only 1 case of steal in this population; it occurred in a brachiophlephalic AVF and ultimately required ligation of the fistula because of intractable symptoms. One wound infection occurred after superficialization but responded to opening of the wound, packing, and antibiotics; this patient went on to use the AVF successfully for hemodialysis. Thrombosis after first use occurred in 2 AVFs (2%).

The rate of reintervention was highest in the BBNS-AVF because most of these AVFs needed their outflow tracts superficialized before use. Of all 28 reinterventions required, 18 were performed before the first use of the AVF for hemodialysis (Table 4). Therefore, once having reached maturity, all upper arm AVFs required relatively few reinterventions to maintain patency. Of 3 thrombectomies attempted, only 1 was successful.

**PATENCY**

Upper arm AVFs that matured were assessed for patency. Kaplan-Meier estimates for primary and assisted primary patency rates for all AVFs are illustrated in Table 4.
Table 4. No. of Reinterventions and Successes for All Upper Arm AVFs

<table>
<thead>
<tr>
<th>Type of Reintervention</th>
<th>No. of Reinterventions</th>
<th>No. of AVFs Successful in Maintaining Patency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before first use</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Superficialization</td>
<td>12&lt;sup&gt;*&lt;/sup&gt;</td>
<td>12</td>
</tr>
<tr>
<td>Angioplasty or stent placement</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Pseudoaneurysm repair</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Incision and drainage</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Thrombectomy</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>18</td>
<td>16</td>
</tr>
<tr>
<td>After first use</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Angioplasty or stent placement</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Ligation of side branches</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Thrombectomy</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Other revision of fistula</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>10</td>
<td>7</td>
</tr>
<tr>
<td>Total</td>
<td>28</td>
<td>23</td>
</tr>
</tbody>
</table>

Abbreviation: AVF, arteriovenous fistula.
<sup>*</sup>Five were performed in the group with brachiobasilic AVFs not superficialized at initial operation (P = .002).

Figures 2 and 3. Two patients were excluded from the life-table calculations for the primary patency rate, and 1 patient was excluded from the life-table calculations for the primary assisted patency rate because of conflicting or incomplete follow-up data. An additional patient was excluded from the primary assisted patency life table because the reintervention was a thrombectomy, implying secondary rather than primary assisted patency. The primary patency rate for all AVFs was approximately 50% (standard error of the mean=6.4%) at 12-month follow-up, while the assisted primary patency rate was 74% (standard error of the mean=6.0%) at 12-month follow-up. When life-table measurements were calculated without considering need for superficialization of BBNS-AVF as a complication, the overall primary patency rate at 12 months remained unchanged at 50%. However, the primary patency rate at earlier times was slightly higher. The Cox-Mantel log-rank test did not show any significant difference between primary or assisted primary patency rates among the different types of AVF. Only 1 AVF became secondarily patent after a complete occlusion but was lost to follow-up after 15 days. Therefore, meaningful conclusions about secondary patency rates cannot be made.

EFFECTS OF COMORBIDITY ON OUTCOME

Each of the clinical characteristics listed in Table 1 was examined to determine the effect on outcomes. Characteristics that did not exert a statistically significant effect on outcomes included smoking, age, hypertension, number of previous hemodialysis access procedures, and time receiving hemodialysis before AVF placement. Patients with diabetes mellitus required a longer time until first use of their AVF than did patients without diabetes (P=.02, t test), as shown in Table 5 and Figure 4. The AVFs in female patients required a higher rate of reintervention than did AVFs in men (P=.12) because a greater number of women underwent placement of a BBNS-AVF. A diagnosis of peripheral vascular disease was associated with a decreased primary assisted patency rate (P=.02, Cox-Mantel log-rank test). However, peripheral vascular disease was not shown to be an independent predictor of worse outcome when analyzed with the Cox proportional hazards model.

COMMENT

Recent advances in medical treatment for patients with chronic renal failure have allowed the initiation of maintenance hemodialysis to be delayed for increasing periods. By the time patients are referred for hemodialysis access surgery, many have edematous arms secondary to fluid retention and have undergone multiple forearm venipunctures for the diagnostic blood analyses that are an integral part of disease management. Furthermore, the life span of patients receiving hemodialysis continues to increase, requiring many patients with ESRD to undergo multiple hemodialysis access procedures. These trends leave many patients with ESRD with no suitable distal forearm veins for creating the AVF of choice—the radiocephalic AVF. The remaining options available to the surgeon are placement of a synthetic arteriovenous graft or creation of a fistula in a different anatomic location.

Synthetic arteriovenous grafts have the advantage of needing less time to mature than do AVFs. However, because of the inferior patency and increased complication rates associated with grafts, the DOQI has recommended that surgeons increase the proportion of fistulas being placed in patients with ESRD. This clear need for a
percutaneous catheters.14 decreases the complications associated with temporary fistula placement.14 Our patients with ESRD are being referred relatively late and are now mandated by the DOQI guidelines to be scheduled for such at a later date. Consequently, undergoing delayed superficialization at 1 of these centers would not necessarily be considered a complication or a termination of primary patency. To address this possible discrepancy, we recalculated the primary patency rate for all AVFs, disregarding superficialization of a BBNS-AVF as an unplanned reintervention. Although the primary patency rate at earlier times improved slightly, at 12 months it was still 50%. Some of this effect can be explained by relatively short follow-up in the BBNS-AVF group after superficialization. However, a more important consideration is that most of the superficializations (7 of 12) were performed in other types of AVF and not necessarily be considered a complication at any institution. There are certain situations, however, in which delayed superficialization is of definite benefit, such as in a patient with a small, relatively thin-walled outflow vein that is in danger of thrombosis if surgically manipulated before dilation takes place.

Ultimately, clinical judgment must determine whether the outflow tract is superficialized at the initial operation. It is our practice to intend to create a radiocephalic AVF, if feasible. However, in our study, the upper arm AVF was the first vascular access procedure for 69% of patients. This large number of patients receiving upper arm fistulas as their first access warrants at least 2 comments. First, as described earlier, radiocephalic AVFs are becoming less feasible in the population of patients being referred for first-time surgical creation of dialysis access. Second, the fact that most of the patients in this cohort had been receiving dialysis for several months without having had any previous attempts at hemodialysis access creation emphasizes that our patients with ESRD are being referred relatively late for surgical consultation. Timelier referral is advantageous and is now mandated by the DOQI guidelines because it increases the likelihood that a native fistula can mature by the time the patient needs hemodialysis and decreases the complications associated with temporary percutaneous catheters.14

The 12-month primary and assisted primary patency rates of the upper arm AVFs in our study (50% and 74%, respectively) are comparable with the rates reported for radiocephalic AVFs, as well as with those previously reported for brachiocephalic AVFs, BB-AVFs, and BMAC-AVFs, 3,7,10,12,15,16 The overall maturation rate of 80% compares favorably with published results for all types of native AVFs, both in the upper and the lower arm.17-19 Sixteen (23%) of 69 AVFs that matured required reintervention to do so. Most of these reinterventions were delayed superficialization of a BBNS-AVF.

To avoid the morbidity associated with extending the incision and dissection medially up the arm, often to the proximity of the axilla, basilic outflow immediately after BB-AVF placement is not routinely superficialized. Nevertheless, 83% (P = .009) of the BB-AVFs that were not superficialized at the initial operation required a second operation for superficialization to become functional for hemodialysis. This observation suggests that the surgeon placing a BB-AVF should consider superficialization of the basilic outflow during the initial operation instead of waiting to see whether the outflow tract will be superficial enough for hemodialysis once it dilates. Although superficialization of the basilic vein requires a longer and more complex procedure, it was not associated with any specific wound complications in this series other than an isolated wound infection that did not affect patency.

At some institutions, all patients undergoing creation of BBNS-AVFs who do not undergo basilic outflow superficialization at the initial procedure are routinely scheduled for such at a later date. Consequently, undergoing delayed superficialization at 1 of these centers would not necessarily be considered a complication and a termination of primary patency. To address this possible discrepancy, we recalculated the primary patency rate for all AVFs, disregarding superficialization of a BBNS-AVF as an unplanned reintervention. Although the primary patency rate at earlier times improved slightly, at 12 months it was still 50%. Some of this effect can be explained by relatively short follow-up in the BBNS-AVF group after superficialization. However, a more important consideration is that most of the superficializations (7 of 12) were performed in other types of AVF and would probably be considered failures of primary patency at any institution. There are certain situations, however, in which delayed superficialization is of definite benefit, such as in a patient with a small, relatively thin-walled outflow vein that is in danger of thrombosis if surgically manipulated before dilation takes place.

Ultimately, clinical judgment must determine whether the outflow tract is superficialized at the initial operation.
operation. A surgeon who discovers, at the time of the operation, that the only outflow vein available is abnormally small and thin walled may elect delayed superficialization. To avoid the need for reintervention, however, our data suggest superficialization should be performed at the initial procedure if the veins appear robust enough to withstand superficialization in their undilated state.

Complications are well-known to plague any type of hemodialysis access procedure. In the present study, 47% of patients had a complication interfering with the function of their upper arm AVF. Such complications are usually not directly life threatening and can often be overcome, as evidenced by the high assisted primary patency rate. Most reinterventions took place before first use, indicating that once matured, upper arm AVFs tended to remain functional. The most frequent cause of failure not amenable to reintervention was thrombosis; 13 (15%) patients had this complication, and only 1 regained secondary patency. Aside from the increased need for superficialization in the BBNS-AVFs, there were no significant differences in complication rates among the AVF groups.

Given that the prolonged use of temporary dialysis catheters is associated with significant risks, particularly thrombosis and infection, time to first use for AVFs is an important clinical outcome variable. If the time to maturation was known, nephrologists could accurately gauge the timing for referral for hemodialysis access surgery. One of the potential limitations of this study is that time to first use may not necessarily reflect time to maturation. If a patient undergoes AVF creation before starting hemodialysis, the AVF may mature before its first use for hemodialysis. In our study, however, 68 (79%) of 86 patients were referred for vascular access after starting hemodialysis. Additionally, the mean preoperative hemodialysis time was 5.7 months. Although earlier referral is clearly preferable, the late referral pattern in our study lends accuracy to correlating the time to use with maturation. In our study, most AVFs were used as soon as they matured.

The mean ± SD time to first use of all upper arm AVFs was 3.8 ± 2.1 months. This interval is consistent with those previously reported for upper and lower arm AVFs in the United States but, not surprisingly, substantially longer than that reported for arteriovenous grafts. The BB-AVFs not undergoing immediate superficialization had the longest time to first use because they almost always needed reintervention. The AVFs in patients with diabetes mellitus took longer to mature than did those in patients without diabetes; nevertheless, eventually the rate of maturation was equivalent. The clinical implication is that AVFs in patients with diabetes may need more time to mature, so timely referral is especially important in this population. In previous studies, diabetes was shown to adversely affect patency in both upper and lower arm AVFs, but, to our knowledge, the time to maturation has not been specifically addressed. Neither diabetes nor any other clinical characteristic independently affected patency in the present study. Nevertheless, to our knowledge, our study results are the first to suggest that diabetes may increase time to maturation.

In summary, aside from the specific problems associated with the delay of basilic vein superficialization, there were no significant differences in outcomes among the 3 types of upper arm AVFs. Specifically, all 3 matured at least 75% of the time and had good primary and assisted primary patency rates. It is tempting to speculate that the BMAC-AVF might have superior performance because of its potential dual outflow tracts.

Although performances of these 3 upper arm AVFs were observed in parallel in this study, they cannot be truly compared because they were not assigned to each patient in a randomized fashion. Individual patient anatomy influenced which AVF was created for each patient. What can be concluded, however, is that all 3 upper arm AVF types—brachiocephalic AVFs, BB-AVFs, and BMAC-AVFs—are effective means of providing hemodialysis access. Therefore, the hemodialysis access surgeon creating an upper arm AVF has 3 valid options for venous outflow and can confidently use whichever best suits the individual anatomical situation.

To meet DOQI guidelines, surgeons must have a non-synthetic alternative to radiocephalic AVFs for maintenance hemodialysis access. Results of this study indicate that all 3 types of upper arm AVF have maturation and patency rates comparable with those reported for distal arm AVFs. Several findings emerge from this study. When creating a BB-AVF, serious consideration should be given to superficializing the basilic vein immediately to avoid having to do so later. The AVFs in patients with diabetes mellitus can be expected to require more than 1 month longer to mature than AVFs in patients without diabetes. The different types of upper arm AVFs cannot be compared directly without a prospective, randomized trial, a study design made difficult by the paramount importance of clinical judgment in the selection of which AVF to create. However, we conclude that all 3 types of upper arm AVF perform at or above the current standards for hemodialysis access placement. The 3 types of upper arm AVF provide hemodialysis access surgeons 3 approximately equally effective outflow options to suit the venous anatomy of individual patients.

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Pharmaceutical Costs in Obese Individuals: Comparison With a Randomly Selected Population Sample and Long-term Change After Conventional and Surgical Treatment (The SOS Intervention Study)

Kristina Narbro, PhD; Göran Ågren, MD; Egon Jonsson, PhD; Ingmar Näslund, MD, PhD; Lars Sjöstöm, MD, PhD; Markku Peltonen, PhD

Background: Obesity is associated with increased morbidity rates and pharmaceutical costs. To what extent various medication costs are affected by intentional weight loss is unknown.

Methods: A cross-sectional comparison of the use of prescribed pharmaceuticals was conducted in 1286 obese individuals in the Swedish Obese Subjects (SOS) intervention study and 958 randomly selected reference individuals. Medication changes for 6 years after bariatric surgery were evaluated in 510 surgically and 455 conventionally treated SOS patients. A cross-sectional comparison of the use of prescribed pharmaceuticals was conducted in 1286 obese individuals and 958 randomly selected reference individuals. Medication changes for 6 years after bariatric surgery were evaluated in 510 surgically and 455 conventionally treated SOS patients.

Results: Compared with the reference group, obese individuals were more often taking diabetes mellitus, cardiovascular disease, nonsteroidal anti-inflammatory and pain, and asthma medications (risk ratios ranging from 2.3-9.2). Average anemia and vitamin deficiency medications (difference: +50 SEK/y [US $5]) and anemia and vitamin deficiency medications (difference: −186 SEK/y [−US $19]) but higher costs for gastrointestinal tract disorder (difference: +135 SEK/y [US $13]) and anemia and vitamin deficiency medications (difference: +50 SEK/y [US $5]).

Conclusions: Use and cost of medications are markedly increased in obese vs reference populations. Surgical obesity treatment lowers diabetes mellitus and cardiovascular disease medication costs but increases other medication costs, resulting in similar total costs for surgically and conventionally treated obese individuals for 6 years. (2002;162:2061-2069)

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