Creating functional autogenous vascular access in older patients

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Objective: **Arteriovenous fistulas (AVFs) are the preferred choice for hemodialysis vascular access (AV access); however, there is debate over the utility of AVFs in older patients, particularly concerning access maturation and functionality. We reviewed our AV access experience in patients ≥65 years of age.**

Methods: **We analyzed consecutive AV access patients ≥65 years old with access operations between March 2003 and December 2009. All patients had ultrasound vessel mapping. In addition to overall outcomes review, the data for patients ≥65 years old were stratified into three 10-year increments by age for further analysis. We compared functional patency data for our older patients with those of our non-elderly patients aged 21 to 64 years treated during the same time period.**

Results: **Four hundred sixty-one consecutive AV access patients new to our practice were included in this study. Ages were 65 to 94 years (mean, 73 years). Two hundred thirty-six (51.2%) were female, 276 (59.9%) patients were diabetic, and 103 (22.3%) were obese. One hundred seven (23.2%) patients had previous access operations. Radiocephalic AVFs were constructed in 29 (6.3%) patients, 99 (21.5%) patients had brachial artery inflow AVFs, 330 (71.6%) had proximal radial artery AVFs, and three were based on the femoral artery. Transposition AVFs were used in 124 (26.9%) patients. No grafts were used for AV access in any patient during the study period. Time to AVF use was 0.5 to 6 months (mean, 1.5 months). Primary, primary assisted, and cumulative patency for patients aged 65 to 94 years were 59.9%, 93.7%, and 96.9% at 12 months and 45.3%, 90.1%, and 94.6% at 24 months, respectively. Follow-up was 1.5 to 77 months (mean, 17.0 months). Subgroup age stratification (65-74 [n = 268], 75-84 [n = 167], 85-94 [n = 26] years) found no statistical difference in functional access outcomes. Primary, primary assisted, and cumulative patency rates were not statistically different in the elderly and non-elderly populations (*P* = .29, .27, and .37, respectively). One hundred fifty-six patients died during the study period, 1.3 to 61 months (mean, 20 months) after access creation. No deaths were related to access operations.**

Conclusions: **AVFs are feasible and offer functional and timely AV access in older patients. There was no difference in functional access outcomes for older patients with subgroup age stratification. AVF patency rates were not statistically different in the elderly and non-elderly populations. Cumulative AVF patency for patients ≥65 years of age was 96.9% at 12 months and 94.6% at 24 months. (J Vasc Surg 2011;53:713-9.)**

The National Institute on Aging reports that the United States population aged 65 and over is expected to double in size within the next 25 years. By 2030, more than 70 million people will be 65 years or older. The age group 85 and older is now the fastest growing segment of the U.S. population.[1] The incidence of chronic kidney disease and renal replacement therapy (RRT) are similarly increasing in older individuals and at a higher rate than for the non-elderly population, accounting for most of the increase.[2-4] Vascular access for hemodialysis (HD) using an arteriovenous fistula (AVF) is widely regarded as superior to catheters (CVC) and grafts (AVG) in morbidity, mortality, and overall cost evaluations.[5-10] However, the use of autogenous access in the elderly population is the subject of debate, particularly with regard to the issues of timely access maturation and primary AVF failure rates. Successful AVF outcomes have been reported by some investigators while other authors found less than satisfactory results.[11-20] Life expectancy and quality of life issues are key elements in this discussion. This study reviews our experience providing autogenous vascular access for older patients.

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METHODS

We reviewed our database of consecutive patients new to our practice referred for HD access from March 2003 to December 2009, identifying all individuals 65 years of age and older. We compared primary, primary assisted, and cumulative vascular access patency rates for these patients versus our non-elderly patients aged 21 to 64 years treated during the same time period. In addition, we analyzed these data for patients ≥65 years old stratified into three groups of patients with ages in 10-year segments (Group 1 = 65-74 years, Group 2 = 75-84 years, Group 3 = 84-95 years). Survival rates were calculated for patients ≥65 years of age in addition to survival analysis of the same three subgroups.

All patients underwent ultrasound vessel mapping by the operating surgeon at the initial consultation along with physical examination.[20] Our general sequence of choice for vascular access operations has been the same for all age groups: 1) Radiocephalic AVFs (RC-AVF) when feasible. 2) Mid-arm AVFs, based on the proximal radial artery for inflow when possible.[22] 3) Staged or primary transposition AVFs.[21,23] The basilic vein was the preferred conduit; however, the brachial vein offered an acceptable alternative.[24] 4) Other options were used infrequently including vein translocations, femoral vein AVFs, or saphenous vein AVFs. The ultrasound (US) examination was a key component in selecting the best site and vessels for these AVF options. We find that many older patients have thinning and fragile forearm skin and soft tissue in addition to years of forearm intravenous access and venipunctures. We feel selecting the upper arm cephalic vein as the targeted AVF outflow vein leads to prompt maturation and successful cannulation in most of these patients. Our requirement for minimal outflow vein diameter was 2.5 mm with a tourniquet in place, and an arterial diameter of 2.0 mm. US was used again briefly in the operating suite to confirm the targeted outflow vein and surgical plan.

All patients were followed in the surgical clinic until the new vascular access was fully functional for dialysis, using two needles for repeated HD without use of a catheter. Ultrasound was routinely used in addition to physical examination to evaluate AVF flow volume, vein size and location, and for marking the targeted outflow location prior to the first use of the access. Our general criteria for initial cannulation 4 to 6 weeks after access creation was flow volume by US >400 mL/min and outflow vein diameter >6 mm. For stage 4 chronic kidney disease (predialysis) patients, we considered the access "ready for use" when it met these requirements. These individuals were included in the data analysis as functionally patent if they met the above criteria.

No monitoring protocol was in place; however, problems such as recirculation, inadequate inflow, high venous pressures, or prolonged cannulation site bleeding lead to a surgical evaluation for physical and US examinations followed by a fistulogram and intervention as indicated. Buttonhole (same site cannulation) access technique was encouraged, particularly in transposition AVFs and in those AVFs with shorter cannulation segments.[25] All patients referred with failed or failing AVGs were evaluated for conversion to a secondary AVF.[26] Patients with mild symptoms of steal syndrome but without motor deficit, rest pain, ulceration, or threatened tissue loss were monitored in our clinic without intervention. Physical examination with pulse volume recordings, finger pressures, digital/brachial indexes, pulse oximetry, and access flow measurements were used for evaluation and treatment planning in severely symptomatic individuals with arteriography added if intervention was necessary.

Primary patency was defined as the time (months) with uninterrupted patency and without intervention. Primary assisted patency was the time of uninterrupted patency from the original AVF construction where any interventional procedure was necessary. Cumulative (secondary) patency was the period from the original AVF construction where AVF patency was interrupted by thrombosis, with or without AVF salvage, until abandonment of the access or until completion of the study period. Patency in this study refers to a functional access. It is our practice to construct an autogenous vascular access for every patient.

Statistical analysis was performed using NCSS software (NCSS Statistical Software, Kaysville, Utah) with significance of differences determined at $P < .05$. P values were obtained by Cox multivariate regression analysis. Patients generally received systemic heparinization during the procedures. Neither prophylactic antibiotics nor any form of postoperative anticoagulation were used in our patients. Anesthesia was provided by sedation with local infiltration and the addition of regional block administered by the surgeon through the axillary portion of the incision for transposition procedures. The operations were performed on an outpatient basis at a university-affiliated tertiary medical center by the communicating author. CV8 Gore Tex (Gore & Associates, Newark, Del) suture was used for each vascular anastomosis. This study was approved by our Institutional Review Board.

RESULTS

We identified 461 consecutive patients new to our practice aged 65 years and older who had a permanent vascular access created for HD from May 2003 to December 2009. The mean age was 73 years (range, 65-94 years). Diabetes was the cause of renal failure in 276 (59.9%) individuals. Female gender accounted for 236 (51.2%) patients, and 107 (23.2%) individuals had previous vascular access operations. Medical records identified 103 (22.3%) patients as obese.

During the same study period, 618 patients new to our practice aged 21 to 64 years (mean, 53 years) had a permanent vascular access created for HD, and functional access patency rates for these individuals were compared with our patients aged 65 years and older. Diabetes was listed as the cause of renal failure in 348 (56.3%) of these patients, with 294 (47.6%) females and 221 (35.8%) with previous vascular access operations. Obesity was noted in 170 (27.5%) of these patients.

Primary, primary assisted, and cumulative patency rates were not statistically different in the elderly and non-elderly populations ($P = .29$, .27, and .37, respectively) and are shown in Figs 1, *A-C*. Multivariate analysis using Cox regression found no statistical difference between those individuals aged 21 to 64 years and patients aged 65 years and older in primary, primary assisted, and cumulative patency rates ($P = .19$, .24, and .51, respectively), after adjustment for obesity, diabetes, and gender. Multivariate analysis using Cox regression for patients ≥65 years of age found the risk for primary access failure higher for females (1.35 risk ratio, $P \leq .01$) and approached significance for obesity ($P = .08$). No statistical difference was found for diabetic patients. The risk for assisted (intervention required) access failure was higher for females (1.95 risk ratio, $P \leq .01$) and in obese patients (1.59 risk ratio, $P \leq .02$), with no statistical difference found in diabetic patients. The risk for cumulative (secondary) access failure was higher for females (2.31 risk ratio, $P \leq .02$) and in obese individuals (2.01 risk ratio, $P \leq .05$). There was no statistical difference for diabetic patients. Primary, primary assisted, and cumulative patency rates were not different for the three elderly patient age subgroups ($P = .37$, .38, and .37, respectively). Primary, primary assisted, and cumulative patency for patients aged 65 to 94 years were 59.9%, 93.7%, and 96.9% at 12 months and 45.3%, 90.1%, and 94.6% at 24 months, respectively.

Overall patient survival for individuals aged 65 to 94 years of age was 86.0% at 12 months and 52.7% at 24 months (Fig 2, *A*). Survival for these older patients was not related to gender ($P = .33$) or obesity ($P = .54$), although approached significance for diabetic patients ($P = .09$). Among the three subgroups of older patients after adjustment for diabetes, gender, and obesity, there was a significant difference ($P = .041$) in survival between groups, with group 3 (the oldest patients) found to have shorter survival, as would be expected (Fig 2, *B*).

Simple AVFs were constructed in 337 (73.1%) patients. Of these, 29 were radiocephalic (wrist) AVFs, 53 brachial-cephalic AVFs, and 255 were proximal radial artery AVFs (PRA-AVFs). Transposition AVFs were used in 124 (26.9%) patients. Of these, 79 transpositions used the basilic vein, 35 used the brachial vein, and six used the cephalic vein. The femoral and saphenous veins were each used twice. Fifty-two AVF transpositions were created as primary procedures and 72 were staged. Twelve patients required a surgical AVF revision after a fistulogram and failed attempt at percutaneous intervention. All other access interventions for maturation or maintenance were accomplished with a diagnostic fistulogram and balloon angioplasty as indicated. Mean follow-up was 17.0 months (range, 1.5-77.0 months). Three patients were admitted to the hospital for hematomas with cellulitis that resolved without surgical intervention. One patient had a wound separation that was closed surgically. No deaths were related to vascular access operations. Six patients regained renal function, discontinuing dialysis. They were not cen-

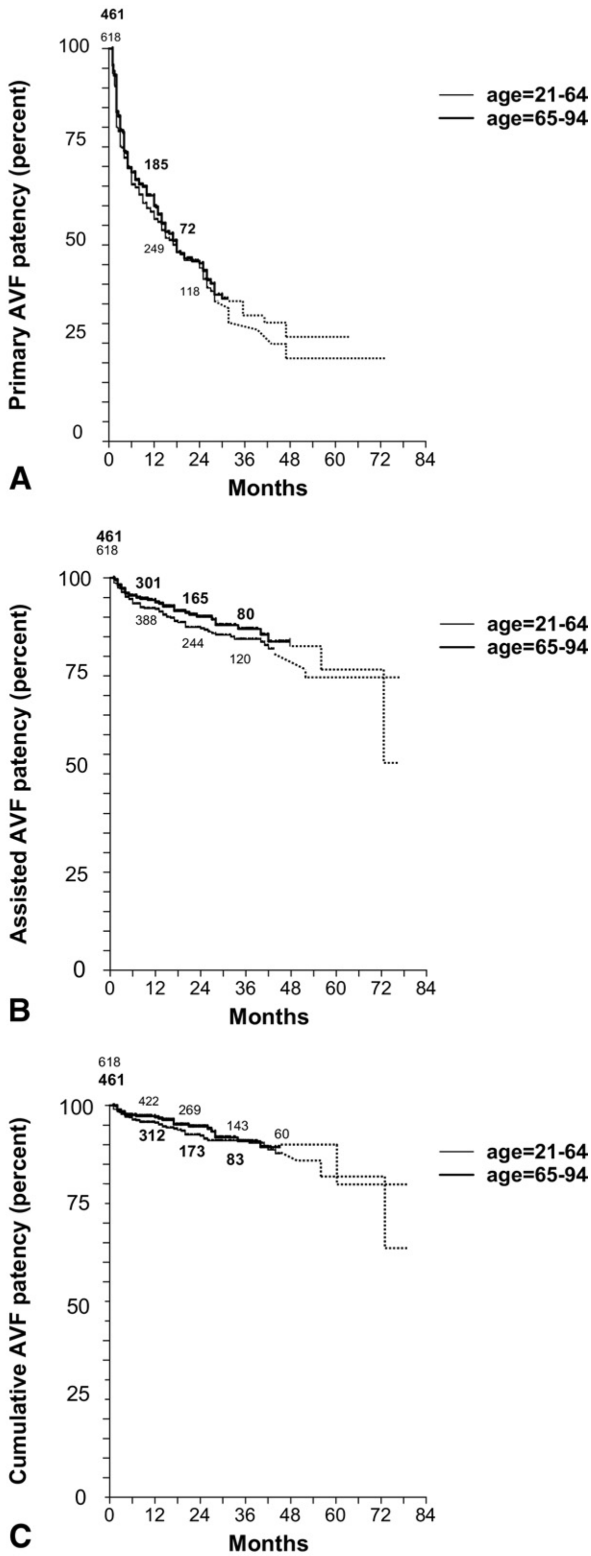

Fig 1. A, Kaplan-Meier vascular access patency curves. Number at risk indicated along curves. Primary arteriovenous fistula (*AVF*) patency was not different in the elderly versus non-elderly populations ($P = .29$). *Dotted lines* are used to indicate when patient numbers were lower and the curves become imprecise. **B,** Kaplan-Meier vascular access patency curves. Number at risk indicated along curves. Assisted AVF patency was not different in the elderly versus non-elderly populations ($P = .27$). *Dotted lines* are used to indicate when patient numbers were lower and the curves become imprecise. **C,** Kaplan-Meier vascular access patency curves. Number at risk indicated along curves. Cumulative AVF patency was not different in the elderly versus non-elderly populations ($P = .37$). *Dotted lines* are used to indicate when patient numbers were lower and the curves become imprecise.

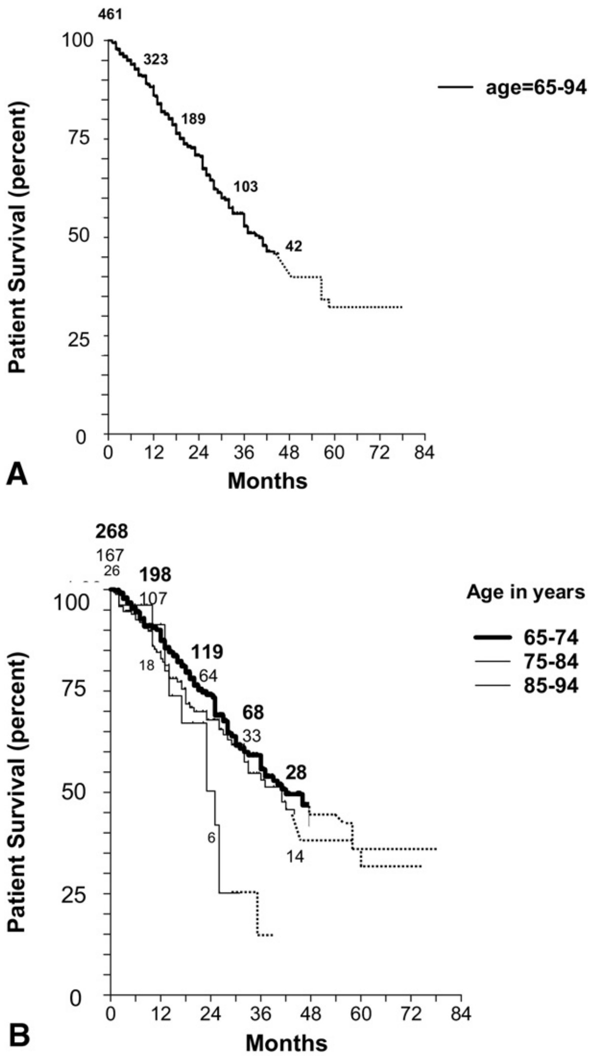

Fig 2. A, Kaplan-Meier patient survival curve for patients 65 to 94 years of age. Number at risk indicated along curve. *Dotted lines* are used to indicate when patient numbers were lower and the curve becomes imprecise. **B,** Kaplan-Meier patient survival curves for patients aged 65 to 94 years stratified into three 10-year increments. Adjusting for diabetes, gender, and obesity, there was a significant difference ($P = .04$) in survival between groups, with Group 3 (the oldest patients) found to have shorter survival. Number at risk indicated along curves. *Dotted lines* are used to indicate when patient numbers were lower and the curves become imprecise.

sored and were followed as pre-dialysis patients during the study period. Seven patients received a kidney transplant and were censored at that time. One of these patients was awaiting a staged transposition; the other patient's AVFs were in use. Fourteen individuals were lost to follow-up at 8 to 58 months (mean, 32 months) and were censored at that point. All of these patients had an access in use or, for pre-dialysis patients, met the functional criteria outlined previously.

The incidence of steal syndrome requiring treatment was not statistically different for patients older than 65 years of age versus individuals aged 21 to 64 years. Steal syndrome warranted intervention in 15 (3.3%) patients ≥65 years of age and in 24 (3.9%) patients aged 21 to 64 years of age. Of the patients ≥65 years of age, six individuals were treated successfully by occlusion of enlarged side branches reducing overall access flow (five of these by coil occlusion and one surgically), two had arterial lesions treated by balloon angioplasty, and seven were successfully treated by a banding procedure as described by Goel et al with our addition of real-time US flow monitoring.[27] Two AVFs were ligated, and two of the salvaged accesses later failed. There were no distal revascularization-interval ligation or axillary artery inflow (proximalization) procedures in this study group of older patients. Two patients with significant lower extremity peripheral vascular disease required a femoral-popliteal bypass using a polytetrafluoroethylene conduit prior to thigh AVF construction. No patient had a graft used for vascular access during the study period.

During the study period, 156 patients died, 1.3 to 61 months (mean, 20 months) after access creation. Eleven of these individuals died with a maturing AVF. None of these deaths were related to the patient's vascular access. These patients' AVFs were maturing satisfactorily and were considered as patent in the data analysis. Secondary AVFs were created in all 58 patients evaluated with failed AVGs (n = 53) or failing AVGs (n = 5), where mature and open outflow veins were available for immediate post operative cannulation. Mean time to initial access cannulation was 1.5 months (range, 0.75-6.0 months) not including the five patients with immediate access cannulation after creation of a secondary AVF.[27] Patients with prolonged time to access cannulation were those requiring staged transpositions, interventions for maturation, staged lipectomy, or vein elevation.[28]

Twenty-eight patients had AVFs that failed and were not salvaged during the study period. Among those individuals with a failed access, nine had a new successful AVF created, one changed to peritoneal dialysis, one received a successful transplant, five were lost to follow-up, and the rest continued catheter-based dialysis treatments. Plans for a new access creation were in place for all catheter-based patients, limited by general health issues, refusal of other procedures, or other issues. Eleven of these patients died during the follow-up period, none due to catheter sepsis. Fifty-eight patients had AVFs created prior to initiation of dialysis; 14 of these patients had not started dialysis at the end of the study period.

DISCUSSION

Hemodialysis vascular access utilizing an AVF has been widely recommended, demonstrating lower morbidity, mortality, and cost than grafts and particularly catheters.[5-10,29] With the population aging and the incidence of renal failure in the elderly increasing, an important debate has emerged as to whether this general vascular access recommendation holds true in older individuals. Age and renal disease are among the independent predictors of morbidity and mortality in older individuals.[4] Both the prevalence rate for dialysis and the median age of the incident population have increased in the United States and are expected to continue rising in future years, emphasizing the importance of this health care discussion.[2-4]

Xue et al analyzed Medicare data for over 66,000 patients older than 66 years of age and found mortality risk was greater in patients with initial vascular access of a catheter or graft as opposed to an AVF.[30] Successful autogenous vascular access outcomes in elderly patients have been reported by several authors.[11,12,14-17] We found AVFs to have the same functional success in our older patients as in younger individuals in our practice. Lok et al reported similar findings.[15] However, Richardson et al reported lower AVF patency rates in elderly (>70 years old) versus non-elderly patients.[18] Chan et al, analyzing the US Renal Data System, also concluded that the potential benefits derived from AVFs compared with AVGs and CVCs may not apply universally for all elderly patients.[13]

Selecting the autogenous access operation with the most likely successful outcome is important for all patients and may be the key element in AVF success for elderly patients. The many AVF options for creation of an autogenous access have been published in the National Kidney Foundation Kidney Disease Outcomes Quality Initiative guidelines, FistulaFirst, Society for Vascular Surgery® clinical guidelines, and others.[5,6,31] US vessel mapping before fistula creation is another key element in success for both elderly and younger patients.[12,20] Simple AVFs are recommended when possible, and distal sites chosen first when feasible. However, several studies have noted a high primary failure rate for radiocephalic fistulas and poor outcomes in all age groups.[16,32] Other authors report success with radiocephalic AVFs in older patients and the general population, proposing that proper patient selection is key in predicting successful outcomes.[33,34] Konner, Lazarides, and others reported mid-arm AVFs, such as perforating vein fistulas and brachiocephalic access, are more likely to be successful in older individuals.[11,14,16] We observed that many of our older patients have thinning and fragile skin changes in the forearm consistent with chronic sun exposure, in addition to poor forearm veins with multiple intravenous infusion and cannulation sites. These patients were best served by construction of an AVF with upper arm access sites. In older and more fragile patients, we most often construct PRA-AVFs with venous outflow limited to the upper arm cephalic vein, avoiding the additional bidirectional forearm venous outflow added in many of our general patient population PRA-AVFs.[22] Patency rates for females ≥65 years of age were lower than for males in this study. Overall vessel size is smaller for females and may be an explanation for this finding. Technical considerations in obese individuals (both surgical and cannulation issues) may be the cause of lower patency rates noted for these patients.

Previous reports found older patients may be at greater risk for steal syndrome with brachial artery inflow access.[35] Use of the proximal radial artery for arterial inflow minimizes this risk, while offering adequate inflow for dialysis access.[22,36] We speculate that those chronic kidney disease patients with severe arteriosclerotic disease may be less likely to survive into the older age groups, contributing, in part, to our finding in this study that steal syndrome was not more common in older patients than in younger individuals <65 years of age. Radial artery AVFs generally offer lower access flows as opposed to brachial artery AVFs, and this may also be important in the elderly population from a cardiac standpoint.[36,37]

Our follow-up evaluation for elderly patients is similar to that for the non-elderly with a goal of cannulating new AVFs within 4 to 6 weeks. Prompt and skilled AVF intervention by fistulogram with angioplasty, when indicated, is important for timely maturation and access maintenance in a substantial percentage of successful AVFs.

As expected, older patients receiving HD in the United States have a lower overall survival than non-dialysis patients and lower overall survival when compared with patients younger than 65 years of age.[2] Jassal et al found life expectancy in elderly HD patients to have improved significantly during recent years adjusting for diabetes, gender, and other comorbidities.[38] They reported the most recent 1-, 3-, and 5-year survival rates among patients aged 65 to 74 years as 78.1%, 51.5%, and 33.5%, respectively, and for those patients ≥75 years of age was 69%, 36.7%, and 20.3%, respectively. Ellam et al reported median patient survival for older patients from first recognition of Stage V chronic kidney disease to be 21 months. Those individuals followed by a nephrologist prior to initiating dialysis had a statistically longer survival (median, 32 months) as opposed to those individuals without a nephrologist (median, 15 months).[39] Survival data for patients ≥65 years of age in our study compared favorably with those of other reports.

Older patients may suffer with "geriatric syndromes" characterized by frailty, falls, and cognitive impairment and are at higher risk for hospitalization, morbidity, mortality, and eventual nursing home placement.[38,40,41] Frailty is common among older dialysis patients and adds to mortality risk following initiation of dialysis. Although early nephrology referral in older patients is thought to reduce adverse chronic kidney disease outcomes, benefits of long-term dialysis in frail older patients remain controversial.[40] Murtagh et al found a survival advantage for patients over 75 years of age with end-stage renal disease who elected dialysis as opposed to those who chose conservative treatment, but the advantage was lost in patients with severe comorbidities, particularly in patients with ischemic heart disease.[42] Yong et al found adverse symptoms and quality of life to be similar for individuals treated with medical and palliative care compared with patients receiving dialysis therapy, pointing out that age should not be the sole factor in deciding on renal replacement therapy, and that quality of life should be taken into consideration as well as overall survival.[41] Couchoud et al constructed a clinical scoring system to predict 6-month prognosis in older patients initiating dialysis treatment.[43] Factors that independently predicted mortality at six months were low body mass index, diabetes, congestive heart failure (Stages III-IV), peripheral vascular disease (Stages III-IV), dysrhythmia, active malignancy, severe behavioral disorder, impaired mobility, and unplanned dialysis. In a study of 3702 nursing home residents, 58% of the individuals died within the first 12 months of starting dialysis, and 29% had a decrease in functional status during that period.[44]

The debate over best medical care for those end-stage renal disease patients who are both frail and elderly with severe comorbidities has not been settled and extends to best medical treatment with or without dialysis, timing of dialysis initiation, methods of HD access, and the role of peritoneal dialysis. With the increasing burden of chronic kidney disease on the Medicare system, this discussion merges best patient care questions with those of increasing Medicare costs. Hemodialysis is the most expensive mode of renal replacement therapy, followed by peritoneal dialysis and transplantation.[45] For some patients, the addition of HD may not prolong life and, in fact, may reduce the quality of life.[46]

Study limitations include the retrospective analysis of patient data and evaluation of a single surgeon experience. Comorbidities such as heart disease were not included in our analysis. Some frail and older patients may have received renal replacement therapy by central venous catheter access without referral for permanent dialysis access, and therefore were not represented in this study. The study data are from a complex referral vascular access practice with over 50 dialysis units represented from several states in addition to local patient referrals with failed access. Patients were recorded as obese for our study from the medical record diagnosis or physical examination, as body mass index was not reliably available. We reported time to initial cannulation, as complete data for each patient's dialysis treatments were not available.

CONCLUSIONS

AVFs are feasible and offer functional and timely hemodialysis vascular access in older patients. There was no difference in functional access outcomes for older patients with subgroup age stratification. AVF patency rates were not statistically different in the elderly and non-elderly populations. Cumulative AVF patency for patients ≥65 years of age was 96.9% at 12 months and 94.6% at 24 months.

AUTHOR CONTRIBUTIONS

Conception and design: WJ, LL, KT
Analysis and interpretation: WJ, LL, KT
Data collection: WJ
Writing the article: WJ, LL
Critical revision of the article: WJ, LL
Final approval of the article: WJ, LL, KT, DP
Statistical analysis: WJ, DP
Obtained funding: WJ
Overall responsibility: WJ

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DISCUSSION

Dr Anil Hingorani (*Brooklyn, NY*). I just had a question about the comparison between the age groups that you had. Was the distribution of the fistulas somewhat similar between the two? Because you had more forearm fistulas in the younger age group that may have explained why your patency rates were somewhat similar.

Dr Jennings. We specifically targeted the upper arm sites in many older patients for prompt cannulation and better skin condition to withstand repeated cannulation. So I'm sure the distribution was different. We did not record final access cannulation sites.

Dr Hingorani. And finally, most of those reinterventions, were they balloon-assisted maturations?

Dr Jennings. We have a very skilled interventional colleague. Almost all interventions were by balloon-angioplasty.

Dr Joe Naoum (*Houston, Tex*). In these elderly patients, especially in those who have very frail and thin skin, is there a time when you just abandon plans to create a fistula and decide to place a graft instead? Is there a specific criteria that you tend to follow for these patients?

Dr Jennings. There were no grafts placed in any of these thousand-or-so patients during the time period studied. So we used no grafts in any of those patients.

Cannulation of either a mature fistula or graft will still require the needle passing through that same fragile skin. We find the skin and soft tissue in older patients to be more substantial in the upper arm. The cephalic vein is a little deeper, which gives you more soft tissue to tolerate repeated cannulation.

We also use button-hole technique when possible and think that that minimizes problems with repeated cannulation through fragile skin.

Dr Eugene Lee (*Sacramento, Calif*). Do you perform your transpositions in a one stage or two-staged procedure?

Dr Jennings. Generally, the vein size determines whether or not we stage or use primary transposition. If the vein is 4 mm or smaller, we use staged procedures. Brachial vein transpositions are almost all staged.

Dr Frank Padberg (*Newark, NJ*). You have for a long time championed the proximal radial artery as a strategy to reduce the incidence of steal. How does that relate to these three patients that developed steal in this series (ie, were any of the 3 radial-based AV access)?

Dr Jennings. We found about 3% with steal syndrome and did not break it down according to inflow site. That's a good comment, and we should look at that. My impression is that radial artery inflow minimizes the risk of steal syndrome.

Dr Marc Mitchell (*Jackson, Miss*). I notice in your survival data, the older patients didn't live much longer than a year or two. Wouldn't they have been better off with just a catheter or a graft?

Dr Jennings. That is a very important question particularly for fragile and older patients: Should they just have a catheter or graft? I'm not sure and that leads to a similar discussion: Are all fragile and older patients best served with dialysis, considering the risks, complications, and quality of life issues for these patients?

There are studies out now reviewing maximum medical therapy versus dialysis and suggesting that dialysis might not be the best answer for every patient. Our paper didn't address that, but it's certainly an important question.