Outcomes of thrombosed arteriovenous grafts: Comparison of stents vs angioplasty

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The usual radiologic approach to thrombosed grafts is a combination of thrombectomy and angioplasty of the underlying lesion. However, the primary (unassisted) graft patency after thrombectomy is quite poor. We evaluated whether graft patency following thrombectomy is improved by placement of a stent in the stenotic lesion. Using a prospective, computerized vascular access database, we identified 14 patients with thrombosed arteriovenous (A-V) grafts treated with a stent at the venous anastomosis (stent group). The outcomes of these grafts was compared to those observed in 34 sex, age-, and date-matched control patients whose thrombosed A-V grafts were angioplastied (control group). Both groups were comparable in age, sex, race, diabetic status, graft age, and number of previous graft interventions. The immediate technical success, as indicated by the post-procedure graft to systemic pressure ratio, was similar in the stent and control groups (0.33±0.16 vs 0.41±0.17, $P=0.14$). The primary graft patency (time from thrombectomy to next intervention) was significantly longer for the stent group (median survival, 85 vs 27 days, $P=0.02$). Assisted or secondary patency (time from thrombectomy to permanent graft failure) was also longer for the stent group (median survival, 1215 vs 46 days, $P=0.049$). In conclusion, treatment of thrombosed grafts with a stenosis at the venous anastomosis with a stent results in longer primary and secondary graft survival, as compared to treatment with angioplasty. Stent placement may be a useful treatment modality in a subset of patients with thrombosed A-V grafts and stenosis at the venous anastomosis.

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Despite K/DOQI guidelines promoting use of arteriovenous fistulas in preference to grafts for hemodialysis access,[1] a substantial proportion of US hemodialysis patients continue to use grafts.[2,3] The majority of graft failures are due to thrombosis, which occurs most commonly in the context of underlying stenosis at the venous anastomosis.[4] Salvage of clotted grafts requires mechanical thrombectomy, in conjunction with angioplasty of the stenotic lesion. Unfortunately, the long-term success rate of this approach is quite poor, and the primary (intervention-free patency) following graft thrombectomy is only 30–63% at 3 months and 11–34% at 6 months.[5–10]

Stent placement has been introduced for treatment of grafts in which angioplasty results in suboptimal technical success or if the stenosis recurs rapidly. A number of small series have reported the outcomes of stent placement for vascular access with refractory stenosis.[11–17] Unfortunately, these studies have suffered from several methodologic limitations, including retrospective data collection, absence of a suitable control group, combining patent and thrombosed grafts, combining stents placed at a variety of stenotic sites, and combining grafts with fistulas. A recent uncontrolled study suggested that stents may improve the patency following graft thrombectomy in selected patients.[11]

To address these limitations, we have evaluated the outcomes of thrombosed grafts treated with thrombectomy and stent placement at the venous anastomosis. We compared the outcomes to those observed in age-, sex-, and time-matched control patients with clotted grafts and stenosis at the venous anastomosis treated with mechanical thrombectomy and angioplasty.

RESULTS

The clinical characteristics of the patients treated with stent and the age-, sex-, and time-matched controls are compared in Table 1. The two treatment groups did not differ significantly in age, sex, race, diabetic status, or frequency of hypertension or coronary artery disease. Moreover, the graft age, number of previous graft interventions, and number of previous vascular accesses were similar between the two treatment groups.

To assess the technical success of the intervention, we measured the intra-graft and systemic blood pressures upon completion of the procedure. The intra-graft to systemic

Table 1 | Baseline characteristics of the study patients

Feature	Stent	Control	*P*-value
Number of patients	14	34	
Age (years)	53±17	58±13	0.24
Sex, female (*N* (%))	10 (72)	21 (62)	0.52
Race, black (*N* (%))	13 (93)	29 (85)	0.47
Diabetes (*N* (%))	5 (36)	15 (44)	0.59
HTN (*N* (%))	12 (86)	30 (88)	0.81
CAD (*N* (%))	4 (28)	10 (29)	0.95
Graft age (days)	296±253	513±478	0.12
# prev interv	2.0±1.8	1.7±2.2	0.66
# prev acc	1.4±1.3	1.6±1.3	0.57

CAD, coronary artery disease; HTN, hypertension; # prev interv, number of previous interventions in the present graft; # prev acc, number of previous vascular accesses (fistula or graft).

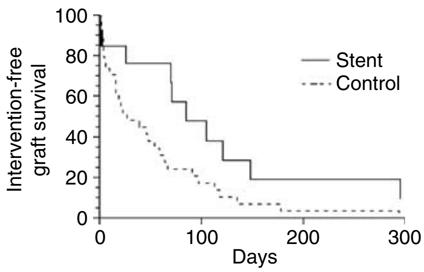

Figure 1 | Primary patency of thrombosed A-V grafts treated with stent after angioplasty (solid line) and control patients (dashed line). $P=0.02$ by the log-rank test.

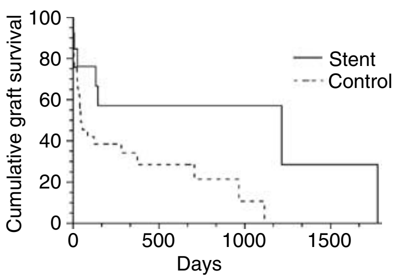

Figure 2 | Secondary patency of thrombosed A-V grafts treated with stent after angioplasty (solid line) and control patients (dashed line). $P=0.049$ by the log-rank test.

pressure ratio was not significantly different between patients treated with stents and those receiving conventional angioplasty (0.33±0.16 vs 0.41±0.17, $P=0.14$).

Unassisted or primary graft patency (time from initial placement to next intervention) was significantly longer for the stent group, with a median survival of 85 vs 27 days, $P=0.02$ (Figure 1). The primary patency was 76 vs 48% at 30 days, 48 vs 24% at 90 days, and 19 vs 3% at 180 days. Assisted or secondary graft patency (time from initial placement to permanent graft failure) was also longer for the stent group, with a median survival of 1215 vs 46 days, $P=0.049$ (Figure 2). The secondary patency was 76 vs 62% at 30 days, 76 vs 42% at 90 days, and 57 vs 38% at 180 days.

DISCUSSION

The majority of arteriovenous (A-V) grafts fail because of thrombosis.[4,18] Unassisted graft survival after thrombectomy and angioplasty is significantly worse than that obtained following elective angioplasty of patent grafts. A comparison of graft outcomes after radiologic interventions at our institution found that the primary patency was only 30% at 3 months for clotted grafts, as compared with 71% for patent grafts undergoing elective angioplasty.[7] Not surprisingly, graft survival was worse if there was a residual stenosis after the angioplasty. However, even in the subset of patients with no residual stenosis after the intervention, the primary 3-month patency was still lower in clotted grafts as compared with patent grafts undergoing elective angioplasty (median survival, 2.5 vs 6.9 months). Modification of the radiologic approach to clotted grafts may improve their survival following the intervention.

Graft stenosis occurs as a consequence of aggressive myointimal hyperplasia, which occurs most commonly at the venous anastomosis.[19] Vascular injury resulting from the angioplasty may actually accelerate the process of myointimal hyperplasia, thereby resulting in early restenosis.[20] Endoluminal stents, by forming a rigid scaffold at the venous anastomosis, may slow the encroachment of the area of myointimal hyperplasia into the vascular lumen, thereby limiting the magnitude of recurrent stenosis. Thus, use of stents may be of utility in preventing restenosis following angioplasty. A small randomized study comparing stents with conventional angioplasty found no difference in primary graft patency following the intervention.[15] However, this study enrolled a mixture of clotted grafts and patent grafts, and the stenotic lesions were at a variety of locations, limiting the interpretation of the findings. A recent study reported the outcomes of clotted grafts undergoing thrombectomy, as well as stent placement at the venous anastomosis.[11] In this more homogeneous group of grafts, the primary graft patency was 63% at 6 months. Although there was no matched control group treated with angioplasty alone, the unassisted graft survival was far superior to that reported in several series (11–34% at 6 months).[5–10]

The present study extends these observations by providing a comparison of the outcomes of clotted grafts undergoing thrombectomy and stent placement at the venous anastomosis with matched control patients treated with thrombectomy and angioplasty. Clotted grafts treated with stents had significantly longer primary and secondary patencies than those treated with conventional angioplasty (Figures 1 and 2). The use of a concurrent, matched control group is important, because several clinical factors have been associated with differences in graft outcomes following angioplasty. For example, the primary patency is shorter in women than men,[21] and shorter if the stenosis is at a peripheral site, as compared with a central vein.[12] Both factors were similar between the stent and control group in the present investigation. The superior graft patency with stent placement is particularly striking, given that the control group appeared to have good technical results after angioplasty alone.

A number of randomized studies evaluating the efficacy of access surveillance on graft outcomes have found that surveillance is an excellent tool for identifying hemodynamically significant graft stenosis. However, the higher frequency of pre-emptive angioplasty in the surveillance group does not appear to translate into a reduction in graft thrombosis or prolongation of graft survival.[22–25] This discrepancy suggests that angioplasty may not be effective in producing sustained improvement of the stenotic lesion. Stent deployment may improve the durability of graft angioplasty and decrease the variability between operators in graft patency following radiologic interventions. Thus, it is possible that more frequent use of stents might enhance the value of graft surveillance.

There are a number of stent types available on the market, but no clinical trials comparing graft outcomes between stent types. It is also possible that administration of anti-platelet agents after stent placement or employment of drug-eluting stents may further improve the primary patency of grafts following thrombectomy. The routine use of clopidogrel after stent placement in the series reported by Sreenarasimhaiah *et al.*[11] may explain the higher 6-month primary patency as compared with the present study (63 vs 19%). Of course, myointimal hyperplasia can still occur at sites other than the venous anastomosis, thereby contributing to recurrent graft failure.

In summary, our results suggest that in thrombosed grafts with a stenosis at the venous anastomosis, treatment with a stent may result in longer primary and secondary graft survival as compared to treatment with angioplasty. Stent placement may be a useful treatment modality in a subset of patients with thrombosed A-V grafts and stenosis at the venous anastomosis. Because employment of stents adds substantially to the cost of treating clotted grafts (~ $1000), a multicenter randomized study is warranted to evaluate the efficacy and cost-effectiveness of this approach in prolonging the primary patency of these grafts. Such a study could also define the specific subsets of patients with clotted grafts who are likely to benefit from stent use.

MATERIALS AND METHODS

Study population

The University of Alabama at Birmingham provides medical care for approximately 450 hemodialysis patients, under the supervision of 12 full-time nephrologists. Two full-time access coordinators hired by the Division of Nephrology schedule all access procedures, and maintain a prospective, computerized database of all vascular access procedures.[26] All endovascular procedures are carried out in the interventional radiology suite by either an interventional nephrologist or an interventional radiologist.

Procedures

All patients diagnosed with a thrombosed graft underwent mechanical thrombectomy within 48 h of diagnosis, in conjunction with angioplasty of the underlying stenotic lesion. The grafts were initially accessed with a single needle at the arterial limb of the graft. A glide wire was passed up to the central vessels and the needle exchanged for a 6-French catheter sheath. Mechanical thrombectomy was achieved with a Trerotola device. A second 6-French sheath was placed in the venous limb of the graft, and a glide wire passed into the arterial circulation. A Fogarty balloon was passed through the wire beyond the arterial anastomosis and pulled back to dislodge the clot. An antegrade and retrograde angiogram of the graft was performed to assess patency and look for stenotic lesions. An angioplasty balloon (Conquest, Bard Inc., Murray Hill, NJ, USA) was placed and inflated at the level of the stenotic site.

If severe elastic recoil or significant residual stenosis was observed, or if the stenosis had recurred shortly after a previous intervention, a stent was deployed at the stenotic site. Different types of stents were used, including SMART, Wallstent, Protégé, and Fluency. Their sizes varied from 7 to 9 mm in diameter and 20 to 40 mm in length. All patients received 3000–4000 U heparin during the procedure.

Upon completion of the procedure, intra-graft and systemic blood pressures were measured. We have previously shown that the intra-graft to systemic pressure ratio was predictive of primary (intervention-free) graft patency.[7,21] None of the patients treated with an endoluminal stent were treated with an anti-platelet agent after the intervention.

Data analysis

The prospective computerized database was used to identify all 887 mechanical graft thrombectomy procedures performed during the 6-year period from 1 April 1999 to 31 March 2005. Of the total, 20 were treated with an endoluminal stent: 13 because of poor technical result after angioplasty, one because of rapid elastic recoil, five because of rapid restenosis after the previous graft intervention, and one because of vascular dissection following the angioplasty. There were no technical complications related to stent placement. The site of stenosis was at the venous anastomosis in 14 patients, the brachiocephalic vein in four, and the peripheral draining vein in two. Because the primary patency may vary by the location of stenosis,[12] we limited the outcome analysis to the 14 grafts with a stenosis at the venous anastomosis.

For comparison, we selected 34 age-, sex-, and time-matched control patients with thrombosed grafts and a stenosis at the venous anastomosis treated with thrombectomy and conventional angioplasty. Using the computerized database, we initially identified for each index patient receiving a stent, all patients undergoing graft thrombectomy in the time period spanning 15 days before the index case to 15 days following the index case. From this list, we selected the two same-sex patients closest in age to the stent patient. Finally, we excluded those patients who did not have a significant stenosis at the venous anastomosis. Permission was obtained from the University of Alabama at Birmingham Institutional Review Board to review each patient's medical records for research purposes.

Demographic and clinical information collected included patient age, sex, race, and comorbidity. The access database was analyzed to determine the date of first intervention (angioplasty, thrombectomy, or surgical revision) subsequent to thrombectomy. Primary (unassisted) patency was calculated from the date of initial thrombectomy to the first subsequent graft intervention. Secondary (assisted patency) was calculated from the date of initial thrombectomy to permanent graft failure, regardless of the number of interventions. Graft follow-up was censored for patient death, change of dialysis modality, or transfer to an outside dialysis facility.

Statistical analysis

Baseline patient characteristics were compared between both groups using Student's t-tests or χ^2 analysis. Survival curves for primary and secondary graft patency were generated using Kaplan–Meier methodology, and the differences between groups were analyzed by the log-rank test.

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