Salvaging prosthetic dialysis fistulas with stents: Forearm versus upper arm grafts

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Objective: We compared results of angioplasty with those of concomitant stent placement to treat thrombosed forearm hemodialysis grafts with results for upper arm grafts.

Material and Methods: Between October 1998 and July 2002, stents were deployed in 61 patients undergoing balloon angioplasty because of venous anastomotic stenosis causing graft thrombosis. Stents were used only in cases of inadequate angioplasty results. Twenty-three forearm grafts and 38 upper arm grafts were treated. All procedures were performed in an endovascular operating suite, with fistulography. Primary and secondary patency rates were analyzed and compared for graft location with the life table method.

Results: Grafts had undergone a mean of 1.56 previous revisions because of thrombosis (forearm: 1.52, upper arm: 1.58; \( P = 0.307 \)). Excluding early thrombosis, a single graft infection was the only procedural complication. Cumulative primary patency rate at 3, 6, and 12 months (from stent placement) was 36.4%, 15.6%, and 0%, respectively, for forearm grafts, which was inferior to the 59.5%, 34.0%, and 17.0% primary patency rate observed for upper arm grafts (\( P = 0.0307 \)). Secondary patency rate was 40.9%, 40.9%, and 30.7%, respectively, for forearm grafts, and 64.9%, 42.3%, and 19.7% for upper arm grafts (\( P = NS \)).

Conclusion: Stent deployment can salvage thrombosed dialysis grafts. However, sustained patency occurs infrequently, with better results for upper arm grafts than for forearm grafts. Inasmuch as surgical revision of forearm grafts is usually straightforward, stenting should be reserved for use in high axillary grafts and other sites where surgical repair is difficult.

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An arteriovenous fistula is the ideal vascular access. Despite efforts in recent years to maximize access, prosthetic bridge grafts are still necessary in about half of patients, despite inferior patency results.\(^1\) The major cause of graft failure is thrombosis, most frequently secondary to stenosis at the venous anastomosis, usually secondary to myointimal hyperplasia. Achieving sustained patency of these grafts requires frequent salvage procedures.

Endovascular techniques are increasingly used to treat thrombosed dialysis grafts. Two prospective randomized studies and a recent meta-analysis of the published experience have suggested superior patency with surgical revision compared with endovascular treatment.\(^2\) \(^4\) However, most of these series included few patients with intraluminal stents, which may enhance patency results.\(^5\) Because we have found that suboptimal technical results are common with angioplasty alone in these fibrotic lesions, we have used stenting more frequently in the last few years. Optimal indications for stenting are not well-defined. The objective of this study was to review our results with stents placed selectively to treat venous outflow lesions associated with access graft thrombosis and to compare results of angioplasty with concomitant stent placement for forearm versus upper arm grafts.

METHODS

We identified patients who underwent venous stent placement at dialysis graft thrombectomy or thrombolysis between October 1998 and July 2002 at Pennsylvania Hospital. Grafts were classified as upper arm for grafts with venous anastomosis proximal to the elbow crease, and as forearm for venous anastomosis at or below the anteceful level.

All procedures were performed in an endovascular operating room suite with intraoperative fistulography. Graft declotting was performed with Fogarty catheter surgical thrombectomy, mechanical thrombectomy with the Angiojet Rheolytic Thrombectomy System (Possis Medical, Minneapolis, Minn), or thrombolysis with pulse-spray urokinase (Abbott Laboratories, Abbott Park, Ill). In all patients the indication for stent deployment was inadequate angioplasty results (>30% residual stenosis), usually on the basis of elastic recoil. We find elastic recoil to be a frequent issue in percutaneous treatment of venous lesions, probably because of relatively low intraluminal hydrostatic pressure and the fibrous nature of the lesions being treated, occurring in approximately 50% of such lesions treated with angioplasty alone.

Patient demographics, clinical factors, and outcome were recorded from office and hospital charts. Variables analyzed included the number and method of previous interventions on the graft, stent characteristics, procedural complications, and patency. Primary patency was defined as the period from stent deployment until any further inter-
vention or graft abandonment. Secondary patency was defined as the time from stent placement to graft abandonment, regardless of number and type of interventions. All grafts were immediately usable for dialysis access after the procedure, and no patent grafts were unusable for dialysis during follow-up.

Data were analyzed in accordance with the suggested standards on reporting of endovascular procedures. Primary and secondary patency rates were calculated with the life table method and were compared with the log-rank test. \( P < .05 \) was considered significant.

**RESULTS**

Sixty-one patients (44 women, 17 men; mean age, 58 years [range, 27-81 years]) underwent balloon angioplasty with adjunctive stent placement to treat venous anastomotic stenosis leading to prosthetic hemodialysis graft thrombosis. Thirty-eighty upper arm grafts and 23 forearm grafts were treated. Preoperative demographic data and risk factors are illustrated by group in the Table. Approximately three fourths of the patients were African American, and three fourths were women. Most patients had hypertension or diabetes. There were no significant differences in age, gender, ethnicity, presence of hypertension, and presence of diabetes mellitus between forearm graft and upper arm graft groups.

During the study, access procedures performed included 176 autogenous fistulas, 302 bridge grafts, 379 surgical graft revisions (302 with thrombectomy), 183 graft thrombectomies, and 146 venous angioplasties. Thus patients undergoing stenting represented a small subset of the access population.

In the forearm group, arterial inflow was from the brachial artery in all patients; venous outflow was to the basilic vein in 13 patients and to a brachial vein in 10 patients. In the upper arm group, inflow was from the axillary artery in 29 patients and the above-elbow brachial artery in 9 patients; outflow was to the brachial vein (proximal to the basilica vein) in 9 patients, the axillary vein within the arm in 20 patients, and the infraclavicular axillary vein in 9 patients.

Only nine grafts (three forearm, six upper arm) had undergone no previous interventions. Mean number of previous interventions in the same graft was 1.56 (upper arm: 1.57, forearm: 1.52; \( P = .05 \)). Two patients underwent thrombolysis, and 11 patients underwent mechanical thrombectomy. Most of the group (48 patients, 78.7%) underwent surgical catheter thrombectomy, and therefore subgroup analysis was not possible.

All stenotic lesions treated in this cohort were located at the venous anastomosis or within the main outflow vein. Stents used included the Wallstent (Boston Scientific, Natick, Mass) in 57 patients, Palmaz stent (Johnson & Johnson, New Brunswick, NJ) in 3 patients; and Symphony stent (Boston Scientific) in 1 patient. Stent size varied from 7 mm × 2 cm to 14 mm × 4 cm (Fig 1). Stent placement across the elbow crease and at the thoracic outlet was not used, because of concern about kinking.

Early graft thrombosis (defined as graft occlusion within 1 week of the procedure) and graft infection were the only complications observed. Five early occlusions occurred, all in the forearm graft group. Early failure was thus significantly more likely in forearm grafts compared with upper arm grafts (\( P = .0027 \)). One graft infection, in an upper arm graft, developed at 35 days postoperatively.

In the upper arm graft group, all 38 stents attempted were deployed successfully. Follow-up averaged 216 days (range, 29-820 days). Cumulative primary patency rate at 3, 6, and 12 months after stent placement was 59.5%, 34.0%, and 17.0%, respectively (Fig 2, A), and secondary patency rate was 64.9%, 42.3%, and 19.7%, respectively (Fig 2, B). Two patients were lost to follow-up.

In the forearm graft group, all 23 stents attempted were deployed successfully. Mean follow-up was 129 days (range, 1-664 days). Cumulative primary patency rate at 3, 6, and 12 months was 86.4%, 15.6%, and 0%, respectively (Fig 2, A), and secondary patency rate was 40.9%, 40.9%, and 30.7%, respectively (Fig 2, B). One patient was lost to follow-up at 350 days after successful kidney transplantation.

Mean number of interventions after stent placement during follow-up was .52 for upper arm grafts and .43 for

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**Table I. Demographic data and comorbid conditions**

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Forearm group</th>
<th>Upper arm group</th>
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<tbody>
<tr>
<td>No. of patients</td>
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<td>38</td>
<td>61</td>
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<tr>
<td>Mean age</td>
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</tr>
<tr>
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<td>36</td>
<td>44</td>
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<tr>
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<td>56</td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>12</td>
<td>52</td>
<td>37</td>
</tr>
</tbody>
</table>

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Mean number of interventions after stent placement during follow-up was .52 for upper arm grafts and .43 for
forearm grafts \((P = \text{NS})\). At log-rank comparison of graft survival curves, primary patency for upper arm grafts was significantly superior to results for forearm grafts \((P = .0307)\). However, there was no statistically significant difference in secondary patency between groups.

**DISCUSSION**

The 2000 United States Renal Data System (USRDS) reported that Medicare expenses for vascular access in patients receiving hemodialysis account for 14% to 17% of total spending for end-stage renal disease. This represents an annual cost of about $8000 per patient. USRDS indicates that 25% of Medicare spending for end-stage renal disease, approximately 3 billion dollars per year, is spent on vascular access alone. More than 20% of all hemodialysis-related admissions in the United States are access-related.

Maintenance of access remains a critical challenge in the increasingly older and sicker population receiving hemodialysis. In a prospective randomized study of endovascular versus open treatment of thrombosed dialysis grafts, we observed a trend toward superior patency with surgical intervention that did not reach statistical significance. In a recent meta-analysis of the available literature, including prospective trials of interventional and surgical graft salvage, it was concluded that surgical thrombectomy remains the standard for treatment of thrombosed prosthetic vascular access grafts, with superior patency and lower cost compared with catheter-based techniques.

It has been our experience in performing balloon angioplasty of venous anastomotic lesions, which in our center are responsible for about 80% of graft occlusions, that suboptimal angiographic results are common. The fibrous nature of the lesion and relatively low luminal pressure at the venous location combine to make elastic recoil a significant problem. Inferior results with angioplasty compared with surgery may in part reflect these suboptimal technical results, and the available published controlled studies included few patients in whom stents were placed because of this indication.

Adjuvant stenting with angioplasty to restore patency of occluded hemodialysis grafts was first reported in 1993. Several reports have concluded that stent deployment is an accepted therapeutic maneuver to salvage thrombosed dialysis grafts, but sustained patency, as with other interventions, is infrequent. Overall primary patency rate at 1 year in this cohort was low, at 17%. This result is similar to the 8% to 36% 1-year primary patency rate others have observed. The question as to whether stenting significantly improves results of endovascular treatment has not been answered. Likewise, subgroups in which results may be better or worse have not been defined.

In several small series, including our own, primary graft patency after hemodialysis graft thrombectomy, angioplasty, and stent placement has been poor, in the range of 12% to 15% at 1 year, not obviously superior to angioplasty results alone. However, these patients tend to represent a subset at high risk, particularly because stents are placed when angioplasty alone yields inadequate technical results.

Although most studies have found superior patency for surgery compared with balloon angioplasty in occluded grafts, in a case-control comparison of stenting and surgical patch angioplasty we found no statistically significant difference between groups. Although the ideal study to evaluate the adjunctive benefit of stents would compare angioplasty alone with selected stents, it would be difficult to accept poor technical results with angioplasty alone in a prospective study.

In addition to cost and potential need for secondary procedures, another concern is that subsequent surgery may be more difficult with the stent in the outflow vein. For this reason, we limit the length of the stent to cover only the lesion proper in most cases, and extend the stent into the graft when necessary.

The results of this study suggest that stenting the venous anastomosis for forearm grafts yields results inferior to those at more proximal locations. Although we did not stratify by vein size in this analysis, most upper arm veins are larger than forearm veins, and vein diameter may have been a factor in the difference in primary patency rate. Superior results with larger veins and greater venous flow are also observed with stenting of central venous lesions. Haage et al reported a 56% primary patency rate at 12 months for such lesions. This may reflect better performance in higher flow situations, as observed with stents in the arterial tree.
It is also possible that, despite efforts to avoid stenting across the elbow crease, kinking of stents may have occurred in some patients in the forearm group. We observed at least two patients with evidence of stent compression at this location.

Given the rapid evolution of stent and thrombectomy technologies, it is difficult to obtain good prospective, comparative data on competing techniques of intervention. In our center, and on the basis of our experience, we selectively use both open and endovascular techniques. Access to outflow veins is readily achievable with relatively simple surgical techniques for forearm grafts. In general, surgery is more effective than endovascular intervention for graft occlusion. Given the inferior stent patency results in forearm grafts in our series, along with these facts, we prefer surgical thrombectomy and revision as primary treatment for thrombosed forearm dialysis grafts. For upper arm grafts, results with stents may be competitive with surgical results, and endovascular treatment has a role. We particularly prefer this approach in obese patients with high axillary or infraclavicular venous anastomoses, because the risk for surgical morbidity (eg, infection, nerve injury, anesthesia-related complications) may be higher in this setting. Whether newer methods such as stent grafts or drug-eluting stents will produce better patency, justifying an

Fig 2. A, Primary patency rate, upper arm grafts (diamonds) versus forearm grafts (squares). B, Secondary patency. Standard error of mean exceeds 10% beyond 23 months for A and beyond 17 months for B.
increasing endovascular role for dialysis graft salvage, remains to be seen.

Inasmuch as the durability of both endovascular and surgical revision of thrombosed dialysis grafts is poor in most patients, concomitant autogenous fistula construction in the contralateral arm should be considered when declotting a graft. Revision procedures such as angioplasty or stenting should be considered a bridge to establishment of more durable autogenous access.

REFERENCES