Treatment of stenosis and thrombosis in haemodialysis fistulas and grafts by interventional radiology

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Abstract

Background. There are no large series reporting the long-term results after radiological treatment of both stenosis and thrombosis in native fistulas (AVFs) and prosthetic grafts.

Methods. Between 1987 and 1999, 726 dilations, 135 stent placements and 257 declotting procedures were performed in 209 consecutive forearm AVFs, 74 upper arm AVFs and 156 prosthetic grafts. The stents used were the Wallstent*, the Craggstent*, and the Passager*. Declotting was performed by manual catheter-directed thromboaspiration, with or without previous urokinase infusion.

Results. The initial success rates ranged from 78 to 98%. The rate of significant complications was 2%. Primary patency rates at 1 year were twice as good for forearm AVFs (50%) than for grafts (25%) (P < 0.05), and were 34% for upper arm AVFs. Secondary patency rates were similar in the 3 groups at 1 year (80–86%) and at 2 years (68–80%). Reintervention was necessary every 18 months in forearm AVFs compared to every 9 months in grafts (P < 0.05). Thrombosed grafts fared worse than failing grafts. Accesses of less than 1 year’s duration needed more reinterventions than older accesses (every 16 months versus 30 in forearm AVFs, every 7 months versus 13 in grafts, P < 0.05).

Conclusions. The percutaneous treatment of stenosis and thrombosis in haemodialysis access achieves patency rates similar to those reported in the surgical literature and confirms that grafts must be avoided as much as possible given their poorer outcome, especially after the first thrombosis. Poorer outcome is also demonstrated in accesses of less than 1 year’s duration.

Keywords: declotting (thrombolysis, thromboaspiration), dialysis vascular access; percutaneous transluminal angioplasty; stents and prostheses

Introduction

Since the first publications in the early 1980s, many articles have been published about the radiological treatment of failing (poorly functioning) and failed (thrombosed) vascular accesses for haemodialysis, after dilation, stent placement or declotting [1–11]. Although the value of the radiological approach was officially recognized by the American DOQI-guidelines in 1997 [12], there is, nevertheless, still little radiological literature concerning native fistulas (AVFs) and the long-term outcome of all types of arteriovenous access after dilation or percutaneous declotting. There has been no series attempting to evaluate the radiological approach as a whole whereas the majority of surgical literature available concerns secondary patency rates starting from the creation of the vascular access and including all types of secondary surgical procedures on both patent and thrombosed vascular accesses. This study aims to help fill this gap by reporting the results of 12 years’ experience at a single radiological centre of the radiological management of stenosis and thrombosis in both AVFs and grafts. The goal of this article is to report the safety of interventional radiology in this field, to compare its results with previously published surgical data and to demonstrate different outcomes between grafts and forearm AVFs, between forearm and upper arm AVFs, and between failing and failed grafts.

Subjects and methods

Radiological imaging with subsequent treatment of abnormalities was requested by nephrologists and surgeons in view of clinical abnormalities.

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Between 1987 and 1999, 1118 radiological treatments (726 simple dilations, 135 dilations with stent placement, 25 declottings) were performed in 439 consecutive haemodialysis accesses of 364 patients in a single radiological centre. They comprised 209 forearm AVFs, 74 upper arm AVFs and 156 prosthetic grafts (21 bovine carotid arteries, 135 PTFE). Data were collected retrospectively before 1992 (63 cases) and prospectively thereafter (376 cases). The first radiological procedure was in 155 cases a simple dilation versus 54 declottings in forearm AVFS, 65 dilations versus nine declottings in upper arm AVFs and 98 dilations versus 58 declottings in grafts.

Grafts were located in the forearm in 94 cases (63 loop, 31 straight), in the upper arm in 59 cases (all straight), and in the thigh in three cases (one loop, two straight). In the forearm fistula, upper arm fistula and prosthesis graft groups, the proportions of women were 37, 45 and 50% respectively: the difference is significant between the forearm AVF and the graft group ($P < 0.02$). The proportions of diabetes were 15, 21 and 20% respectively (NS). The proportions of black people were 0.5, 0 and 2% in the three groups respectively. Mean patient age was 63 years in the forearm AVF group and 64 in both the upper arm AVF and graft groups. Patients were referred from six different hemodialysis centres (only two in 1987, four additional centres from 1992), representing 18 different nephrologists. From 1992, the vast majority of vascular access problems were, therefore, referred directly by the nephrologists to the radiology centre for diagnostic arteriography, and for concomitant treatment when possible.

All radiological interventions were outpatient procedures, except when significant clinical complications occurred immediately or when the patients underwent their dialysis treatment late in the evening after declotting.

We now describe the details of the radiological approach from 1987.

### Dilation

The principles of the dilation technique were those described in 1993 [2]. Dilation was performed after direct puncture of the vascular access in the direction of but far enough from the stenosis to dilate and high pressure balloons that can be inflated to 25 atmospheres (‘Blue-Max’, Medi-Tech, Natick, Ma, or ‘Centurion’, Bard, Covington, GA, USA) were routinely used for a mean inflation time of 3 min.

### Stents

Only self-expandable stents were used: the Wallstent from 1989, the Craggstent and the Passager from 1993 (all three nowadays manufactured by Boston Scientific Europe, La Garenne-Colombes, France). The Wallstent is a metallic stent comprising Cobalt. The Craggstent is the bare version of the Passager, a nitinol stent covered with Dacron. Both Wallstent and Passager were modified by their subsequent manufacturers after their initial launch on the market.

Indications for stent placement comprised complications and limitations of dilation: acute ruptures not controlled by prolonged balloon inflation, greater than 30% residual stenosis despite no residual waisting on the balloon, and early recurring restenosis (<6 months). Stents were also placed to treat aneurysms. No anticoagulants or antiplatelet agents were given after either dilation or stent placement.

### Declotting

Thrombosed accesses were routinely declotted percutaneously from 1992. The initial technique [9] combined local infusion of urokinase for 2 h and secondary manual aspiration of residual clots through 8F large lumen catheters (‘Brite-Tip’, vertebral or multipurpose curve, Cordis, Miami, FL). The urokinase infusion stage was abandoned from 1994 and since that time clots have been directly aspirated after placement of two 7F or 8F introducer-sheaths in opposite directions to gain access to both the arterial inflow and the venous outflow [10]. An underlying stenosis was unmasked and dilated in all cases.

### Evolution from 1987 to 1999

Balloon dilation was the only percutaneous method used in 1987. The complications, including early recurring stenoses, were treated surgically. From 1989, some selected cases were treated by placement of a Wallstent that became routinely available from 1991. Early recurring stenoses that were operated on before the availability of stents were treated by stent placement from 1992 after multidisciplinary discussion. Covered stents became available from 1993.

After occasional successful attempts in 1991, systematic radiological treatment of thrombosed AVFs and grafts was initiated from 1992 and the surgical option was abandoned. From 1994, manual catheter-directed thromboaspiration was the single percutaneous technique used. Long stenoses and chronic occlusions were initially considered as contraindications for dilation, except for central veins. Improvement of catheters and guide wires from 1992 and the routine availability of stents led to reconsideration of the radiological approach.

Immature native fistulas were initially considered to be contraindications to any interventional radiology procedure. Encouraging results obtained incidentally from 1994 led us to consider that non-anastomotic stenoses on the feeding artery or on the vein could be successfully treated by percutaneous means. Similarly, thrombosed immature fistulas were declotted percutaneously from 1995 if it was established that the fistula had been successfully used for dialysis at least once.

In 1999, the only absolute contraindications to percutaneous treatment were local infection, never previously used thrombosed immature fistulas and hand ischaemia with stenosis on the fistula itself.

### Surveillance

Surveillance and monitoring after interventional radiology treatments was the responsibility of the nephrologists who initially referred the patients. Recurrence of clinical abnormalities necessitated a further angiogram, with concomitant redilation in cases of restenosis.

### Statistics

The results are reported according to the Kaplan–Meier life-table method. Success was defined as a less than 30% residual stenosis and/or normalization of the clinical abnormalities after dilation and as the ability to perform at least one full dialysis treatment after declotting. Major complications were defined as those with impairing clinical consequences and that necessitated an additional intervention or inpatient hospitalization. Primary patency was considered to begin on
the day of the first radiological procedure and to end on the
day of access failure or further reintervention (radiological
or surgical). Secondary patency included all further radiolog-
cal therapy (dilation, stent placement, declotting) but ended
with any surgical intervention. Death and renal transplanta-
tion with a patent fistula were considered to be the end of
follow-up.

The interval between interventions was defined as the
duration of patency between two radiological interventions
performed to maintain or to restore patency. Mean intervals
between interventions were calculated as follows. The follow-
up time after the first successful radiological procedure until
the last reintervention was divided by the number of proced-
ures performed. For patients with more than 6 months
follow-up without reintervention, the current follow-up period
(at patient’s death, renal transplantation or in
September 1999) was considered to be the (underestimated)
terval between interventions. The paired Student’s t-test
was used for comparison of patency rates and intervals. A
value of 0.05 was used to determine statistical significance.

Results

Clinical abnormalities and location of stenoses

Clinical abnormalities leading to first radiological pro-
cedures varied in frequency according to the type of
vascular access and they were of course in
forearm problems. The vast majority of stenoses (86%) were less than
2 cm long. Only 2.3% of patients were referred first for a
problem related to stenosis of a subclavian or brachi-
cephalic vein and 6.1% of the patients were dilated at least once on central veins during the entire follow-
up period.

Cumulative patency rates

Primary patency rates after inaugural dilation of failing
fistulas or grafts or declotting of failed fistulas and grafts are detailed in Table 2 and they include initial
failures. Primary patency rates at 1 year were 50 ± 4%
for all (failing + thrombosed) forearm AVFs (n = 64),
34 ± 8% for all upper arm AVFs (n = 13) and 25 ± 4%
for all grafts (n = 27). There was a significant difference in
primary patency rates between forearm AVFs and
grafts at 1 year (P < 0.05).

Secondary patency rates at 1 year were 85 ± 4%
for failing forearm AVFs (n = 88), 80 ± 8% for thrombosed
forearm AVFs (n = 19), 82 ± 6% for failing upper arm
AVFs (n = 20), 65 ± 27% for thrombosed upper arm
AVFs (n = 2), 92 ± 3% for failing grafts (n = 60) and
75 ± 8% for thrombosed grafts (n = 24). At 4 years,
secondary patency rates were 77 ± 8% for failing fore-
arm AVFs (n = 20), 65 ± 17% for thrombosed forearm
AVFs (n = 5), 51 ± 15% for failing upper arm AVFs
(n = 6), 60 ± 10% for failing grafts (n = 15) and
24 ± 15% for thrombosed grafts (n = 2). Secondary
patency rates for all forearm fistulas, for all upper arm
fistulas and for all grafts are presented in Tables 3 and
4.

To achieve these secondary patency rates, a total of
311 simple dilations, 18 stent placements and 60 declot-
tings were performed in the 209 forearm AVFs. In the
74 upper arm AVFs, they comprised 136 dilations, 37
stent placements and 39 declottings. In the 156 grafts,
they comprised 279 dilations, 80 stent placements and
158 declottings.

Complications

The mortality rate within 1 month was 2.1% in the
forearm AVF, 1.9% in the upper arm AVF and 1.8%
in the graft groups of patients, respectively. However,
no death was clearly imputable to the radiological
procedure. Significant complications occurred in 2.1%
of forearm AVF, 1.9% of upper arm AVF and 2.1%
of graft cases, respectively. They included access loss
because of uncontrolled rupture (two cases), acute
pseudoaneurysms (on puncture site or on a dilated
area) requiring surgery within 1 week (five cases), local
or general infection (five cases), haematoma requiring
surgery (two cases), pulmonary embolism (one case),
pulmonary oedema by volume overload (one case),
mesenteric infarction (one case), metabolic acidosis of
unknown origin (one case), need for blood transfusion
(three cases) and iododermitis (two cases). Not all
complications were imputable to the radiological pro-
cedures and complications such as access loss because of
uncontrolled ruptures occurred early in our experi-
ence before stents were available. Minor complications
such as small haematomas, transient cutaneous rashes
and prolonged nausea have not been taken into
account and other minor incidental complications are
obviously underestimated: for example, patients rarely
complained of iodine mumps if they were not specifi-
cally questioned.

Dilation-induced rupture occurred in 8.3% of fore-
arm AVFs but stents were eventually necessary in only
4/32 cases (13%). Rupture occurred in 14.9% of upper
arm AVFs (mainly in the final arch of the cephalic
vein and at the end of the transposition in brachio-
basilic fistulas), stents being necessary in 7/31 cases (23%). In grafts, rupture occurred in 3.8% of cases, with resort to stents in 5/20 cases (25%). Stenoses resistant to dilation occurred in 1.3% of forearm AVFs, 4.8% of upper arm AVFs (mainly in the final arch of the cephalic vein) and 1.6% of grafts.

Specific complications of stent placement included two stent migrations (one Wallstent and one Passager) with subsequent percutaneous retrieval of stents. Transient arterial embolisms during access declotting procedures were not counted as complications since all of them were immediately successfully treated by thromboaspiration and were considered to be simple technical difficulties.
Table 2. Primary patency rates (+ standard error) after the first radiological treatment, with separation of failed from failing vascular accesses in the 3 types of vascular access (n=number of patients at risk at start of interval)

<table>
<thead>
<tr>
<th>Access</th>
<th>Success</th>
<th>1 month</th>
<th>3 months</th>
<th>6 months</th>
<th>12 months</th>
<th>24 months</th>
<th>36 months</th>
</tr>
</thead>
<tbody>
<tr>
<td>Failing forearm AVFs</td>
<td>95 ± 2</td>
<td>94 ± 2</td>
<td>84 ± 3</td>
<td>67 ± 4</td>
<td>51 ± 5</td>
<td>37 ± 7</td>
<td>32 ± 8</td>
</tr>
<tr>
<td>n=155</td>
<td>n=148</td>
<td>n=139</td>
<td>n=118</td>
<td>n=81</td>
<td>n=50</td>
<td>n=19</td>
<td>n=10</td>
</tr>
<tr>
<td>Thrombosed forearm AVFs</td>
<td>94 ± 3</td>
<td>89 ± 4</td>
<td>89 ± 5</td>
<td>74 ± 7</td>
<td>47 ± 9</td>
<td>43 ± 12</td>
<td>36 ± 13</td>
</tr>
<tr>
<td>n=54</td>
<td>n=51</td>
<td>n=44</td>
<td>n=37</td>
<td>n=27</td>
<td>n=14</td>
<td>n=7</td>
<td>n=5</td>
</tr>
<tr>
<td>Failing upper arm AVFs</td>
<td>97 ± 3</td>
<td>91 ± 4</td>
<td>84 ± 5</td>
<td>57 ± 7</td>
<td>35 ± 8</td>
<td>24 ± 9</td>
<td></td>
</tr>
<tr>
<td>n=65</td>
<td>n=63</td>
<td>n=55</td>
<td>n=49</td>
<td>n=25</td>
<td>n=12</td>
<td>n=5</td>
<td></td>
</tr>
<tr>
<td>Thrombosed upper arm AVFs</td>
<td>78 ± 14</td>
<td>67 ± 16</td>
<td>54 ± 18</td>
<td>27 ± 16</td>
<td>27 ± 23</td>
<td></td>
<td></td>
</tr>
<tr>
<td>n=9</td>
<td>n=7</td>
<td>n=6</td>
<td>n=4</td>
<td>n=2</td>
<td>n=1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Failing prosthetic grafts</td>
<td>98 ± 1</td>
<td>96 ± 2</td>
<td>85 ± 4</td>
<td>53 ± 5</td>
<td>29 ± 5</td>
<td>13 ± 5</td>
<td></td>
</tr>
<tr>
<td>n=94</td>
<td>n=96</td>
<td>n=94</td>
<td>n=81</td>
<td>n=46</td>
<td>n=20</td>
<td>n=6</td>
<td></td>
</tr>
<tr>
<td>Thrombosed prosthetic grafts</td>
<td>98 ± 2</td>
<td>84 ± 2</td>
<td>63 ± 6</td>
<td>32 ± 6</td>
<td>17 ± 6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>n=58</td>
<td>n=57</td>
<td>n=48</td>
<td>n=35</td>
<td>n=18</td>
<td>n=7</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Statistically poorly significant figures, i.e. those resulting from fewer than 10 patients or with a greater than 10% standard error, are in parentheses.

Table 3. Radiological secondary patency rates achieved in AVFs after both dilation or declotting compared with the surgical rates after creation of AVFs (after Mehta, [14])

<table>
<thead>
<tr>
<th>Access</th>
<th>1 year (%)</th>
<th>2 years (%)</th>
<th>3 years (%)</th>
<th>4 years (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radiology</td>
<td>80–84</td>
<td>68–80</td>
<td>57–76</td>
<td>51–74</td>
</tr>
<tr>
<td>Surgery</td>
<td>50–94</td>
<td>38–89</td>
<td>29–89</td>
<td>20–89</td>
</tr>
</tbody>
</table>

In the radiological group the lower rates are those achieved in the upper arm and the higher rates those achieved in the forearm. In the surgical group, the extremes are those reported in the meta-analysis of Mehta.

Table 4. As Table 3 but for prosthetic grafts

<table>
<thead>
<tr>
<th>Access</th>
<th>1 year (%)</th>
<th>2 years (%)</th>
<th>3 years (%)</th>
<th>4 years (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radiology</td>
<td>86</td>
<td>75</td>
<td>64</td>
<td>51</td>
</tr>
<tr>
<td>Surgery</td>
<td>67–87</td>
<td>50–83</td>
<td>40–75</td>
<td>40–72</td>
</tr>
</tbody>
</table>

Intervals between procedures

The mean interval between radiological procedures for grafts was 10.05 months when the graft was first treated for stenosis on a patent access, in contrast to only 6.39 months when it was initially declotted (P=0.028). Grafts initially referred for thrombosis were significantly more often recently created (8.52 months) than failing but patent grafts referred for dilation (14.26 months) (P=0.022). For upper arm AVFs the interval was 10.91 months after dilation and 8.57 months after declotting (NS). For forearm AVFs, the interval was similar both after dilation (18.15 months) and declotting (18.79 months). The mean age of forearm AVFs referred for thrombosis (34.4 months) was greater than the mean age of failing but patent fistulas referred for dilation (22.7 months), but the difference did not reach significance (P=0.06).

The mean interval between maintenance reinterventions after inaugural dilation was significantly (P<0.05) better for forearm fistulas (18.1±1.9 months) than for upper arm fistulas (10.9±1.9 months) and for grafts (10.0±1.1 months). The difference was even greater and more significant between thrombosed forearm AVFs (18.8±4.5 months) and thrombosed grafts (6.3±0.9 months). Although raw data look better, the difference between upper arm fistulas and grafts either after inaugural dilation (10.91 versus 10.0 months) or inaugural declotting (8.6 versus 6.3 months) did not reach significance. The mean interval between maintenance reinterventions for all forearm AVFs was 18.3±1.8 months, much better than for grafts (8.7±0.8 months, P<0.001) and than for upper arm fistulas (10.6±1.8 months, P<0.01). However, the 1.9 months difference between grafts and upper arm AVFs was not significant.

Stents

The 135 stents placed since 1988 comprised 88 Wallstents, 16 Cragg stents and 31 Passagers. Stent placement was performed for 7% of forearm AVFs, 28% of upper arm AVFs and 32% of grafts: 80 stents were placed in 49 grafts, 37 in 21 upper arm AVFs and 18 in 15 forearm AVFs. Indications for stent placement comprised acute rupture (16/135=12%), soft stenosis recoil (33/135=24%), stenoses recurring within 6 months (77/135=57%), restenoses within 1 year but over 6 months (8/135=6%), and treatment of pseudoaneurysms (1/135=1%). Only six of the initial stent placements involved stenoses in subclavian or brachiocephalic veins (one in the outflow of a forearm AVF, three in the outflow of an upper arm AVF and two of a graft). When a stent was placed for early recurring stenosis (<6 months), the mean interval between reinterventions increased from 4.1±0.7 to 9.7±1.1 months in forearm AVFs (multiplied by 2.4, P<0.05), from 2.26±0.4 to 4.22±0.7 months in upper arm AVFs (multiplied by 1.9, P<0.05), and from 2.54±0.3 to 5.33±0.8 months in grafts (multiplied by 2.1, P<0.01).
Influence of the age of the vascular access

The interval between reinterventions was significantly shorter in forearm AVFs of less than 1 year (15.94 months) when compared with those of more than 1 year (30.2 months) (P<0.04). This was also true for grafts (6.71 versus 12.84 months, P<0.001). The number of thrombosed AVFs was too small in the upper arm group to allow similar comparison. The grafts with mean reintervention intervals of less than 6 months were clearly more recently created (6.91 months) than those with intervals greater than 6 months (17.84 months) (P=0.0001).

Discussion

All the results reported in this article originate from a single radiological centre and, therefore, unintentional selection bias is possible. Other teams using other techniques in different populations might have different conclusions.

For example, no differences were found in this study between forearm and upper arm grafts, or between straight and loop grafts, which explains why we constructed a single graft group for statistical purposes. Similarly, no differences were found between radiocephalic and radio- or ulnar-basilic fistulas, or between brachioccephalic and transposed brachiobasilic fistulas, leading to the creation of a single forearm fistula group and a single upper arm fistula group. More extensive series might, however, reveal differences in the future. For example, Safa [13] reported differences in outcome between straight and loop grafts after dilation in a smaller group of patients than ours, but with a majority of grafts placed in the forearm whereas the majority of our straight grafts were in the upper arm.

The vast majority of surgical reports provide life-table analyses starting from the creation of the AVF or graft, with little or partial information concerning revisions, whereas this study reports data starting from the ‘radiological revision’ of the failing and failed accesses. There are, however, several points common to both approaches. For example, long-term secondary patency rates are identical after surgical creation and radiological revision if we compare our radiological results with the surgical data of the meta-analysis of Mehta published in 1991 [14], both for AVFs and grafts (Tables 3 and 4). This means that radiologically-revised accesses have the same life expectancy as newly created fistulas or grafts and, therefore, that revisions are not only desirable but effective. Surgical rates from Mehta’s meta-analysis are nevertheless overestimated since they stopped in 1989. The haemodialysed population is nowadays older and more debilitated, with more diabetics, and the recent surgical rates published by Hodges [15] are for example below the lowest rates of Mehta’s review of the literature.

Lower initial success rates indicate that forearm AVFs are not only more difficult to create but also more difficult to revise than grafts, but the outcome is much more rewarding, with higher secondary patency rates from the second year and many fewer maintenance reinterventions overall. The ratio of reinterventions is 1 to 4 in favour of forearm AVFs after surgical creation in the compilation of Mehta [14] and the ratio is 1 to 7 in Hodges’s recent single centre study [15]. This ratio is lower but still very significant after radiological revision in our series (1 to 2 after dilation, 1 to 3 after declotting). Both surgical and radiological data confirm that a forearm fistula is the access of choice and is not created often enough in some countries and centres because, as emphasized by Hodges et al. ‘objective measures such as patency rate or adequacy of dialysis have less influence on the choice of access than physician preference and geographic bias’.

There are relatively few surgical reports allowing more direct comparison with radiology in the treatment of stenosis and thrombosis in AVFs and grafts. In 1997, Gray summarized the data available in the literature [3], which included some short randomized trials, and he concluded that ‘the available literature suggests that percutaneous treatments are at least as effective as surgery when long-term patencies are evaluated’.

More recent surgical series did not provide arguments for a different conclusion. Hodges et al. reported a 36% 1-year primary patency rate after surgical revision of failing grafts, similar to the 29% rate of our series which is between the 10 to 40% radiological rates of the literature [3,15].

Oakes reported a 57% 1-year primary patency rate after surgical treatment of both failing and thrombosed forearm AVFs, in agreement with our 50% rate, but surgery often consisted of making a clearly more proximal anastomosis that sacrificed long venous segments [16]. Hodges, Marston, and Dougherty [15,17–18] reported 1-year primary patency rates ranging from 23 to 26% for thrombosed grafts after surgical revision, which were not clearly better than our 17% rate which is between the 8 to 26% rates in the radiological literature [3].

As there are now sufficient findings to show that surgical and radiological approaches can lead to similar results, the time has probably come for an open discussion about the best indications for both techniques according to the lesion and its location, the type of access and the patient’s history.

During the long follow-up period of this study we have dilated or declotted grafts placed by a first surgeon in four patients who were referred months or years later for treatment of a failing or failed forearm native fistula created by a more experienced and dedicated surgeon, who had simply requested prior venous mapping using upper limb venography. It should be emphasized that in two cases the surgeon created an ulnar-basilic fistula, an excellent native forearm fistula which is strangely mentioned nowhere in the American DOQI-guidelines. Preoperative venous mapping by either venography or duplex ultrasound is also probably the reason why our success rate (98%) is so high in the treatment of clotted grafts: the surgeons had the
benefit of venous mapping most of the times they placed a graft, thus helping them choose the best site for venous Anastomosis, and we know that poor outflow veins are the major cause of technical failure in radiological series. The extensive use of preoperative venography probably also explains why the 6.1% of our patients treated for central vein lesions are, for example, clearly less than the 17% of another recent European study [8]: when a subclavian or brachiocephalic stenosis was diagnosed in our institutions, the contralateral limb was systematically preferred. In addition, subclavian catheters have been prohibited for 20 years in our nephrology and intensive care units.

According to our results, forearm AVFs fare better than grafts, which has already been reported in the surgical literature, but they also fare better than upper arm AVFs, which has never been clearly demonstrated until now. This poorer outcome is mainly due to the problems encountered in the management of stenoses located in the final arch of the cephalic vein and at the end of the transposition in basilic veins.

The even more disappointing conclusion of this series is that, although raw data look better, upper arm AVFs did not fare significantly better than grafts after radiological revision. However, this difference might reach significance in a larger series and the recent article of Rodriguez confirms that upper arm fistulas fail significantly less often than grafts after surgical creation [19].

In our experience thrombosis is a detrimental factor for the outcome of grafts but not for forearm AVFs. Better outcomes for grafts after simple dilation or surgical revision compared with declotting have already been reported [15,20] and are one of the rationales for prophylactic dilation of stenoses before thrombosis occurs, as recommended by the DOQL. The similar outcome after declotting as after dilation of forearm AVFs should not be an incentive for complacency: declotting can be long and difficult and requires more radiological skill and experience than simple dilation or graft declotting. The favourable outcome of declotted forearm AVFs in our series might also be biased by their older average age (close to significance) when compared with fistulas that were simply dilated. In contrast, thrombosed grafts in our group were significantly more often recently created than grafts referred for simple dilation.

The predominance of arm oedema and the low rate of inaugural thrombosis in the upper arm AVF group are normal in terms of initial clinical abnormalities: these are the highest flow fistulas and the higher the flow, and, therefore, the more impeding a central stenosis, the lower the risk of thrombosis.

Conclusion

This long-term study confirms the overall undisputable superiority of native forearm fistulas over prosthetic grafts with, however, less favourable results for upper arm native fistulas. The value of prophylactic treatment of stenoses is also confirmed in grafts. In view of the results achieved with the radiological approach in the treatment of stenosis and thrombosis in all types of haemodialysis access, our opinion is that the percutaneous approach can be attempted as an alternative to conventional surgery in the majority of cases, as long as the local physicians performing the percutaneous techniques are trained and convinced.

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**Editor’s note**

Please see also Personal Opinion by K. Konner, pp. 1922–1923.