Problems of Vascular Access for Haemodialysis—Experience with 214 Patients

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The subcutaneous arteriovenous (A-V) fistula has been the method of choice for achieving vascular access for haemodialysis in our Unit for the last four years. The purpose of this presentation is to evaluate and analyse our experience with 214 patients maintained on haemodialysis for a period of 3 to 44 months.

METHODS AND RESULTS

A subcutaneous A-V fistula between the radial artery and the cephalic vein was the procedure of choice and was performed primarily in 203 patients. Eleven patients had a primary saphenous vein graft done because of unsuitable vessels, many previous shunts, previous drug addiction and extreme obesity. In the fistula series (Table I), there was a 16% failure rate during the first three months following construction of the fistula (this group of 'fistula failures' includes cases in which the fistula was open, however, the flow obtained was not sufficient for dialysis). There were 32 failures in the first three months in 203 patients (several patients had more than one failure). Ten of these were corrected by simple thrombectomy, failure in these cases being unrelated to technical factors or to adequacy of artery or vein. Seven patients required the construction of a new fistula and four patients had to be maintained on a temporary silastic cannula shunt until the fistula became suitable for use. A saphenous vein graft had to be used in 11 of these patients (Table II).

The contributing factors to the early fistula failure are listed in Table III. This includes unsuitable arteries or veins, excessive dehydration and general debility, the presence of outflow venous obstruction, major surgery unrelated to the renal failure and the development of true and false aneurysms. Problem patients were diabetics with advanced arterial sclerosis or some non-diabetic patients in whom extensive arterial calcification was present; advanced age, extreme obesity, previous drug addiction, scleroderma and severe muscle
Table I. Arteriovenous fistula for haemodialysis, experience with 203 patients

<table>
<thead>
<tr>
<th>Number of Patients</th>
<th>Months Therapy</th>
<th>1 CR</th>
<th>2 NF</th>
<th>3 SS</th>
<th>4 VG</th>
<th>Number Failure</th>
<th>Failure Rate%</th>
<th>Patency Rate</th>
<th>Patient Months</th>
</tr>
</thead>
<tbody>
<tr>
<td>203</td>
<td>3</td>
<td>10</td>
<td>7</td>
<td>4</td>
<td>11</td>
<td>32</td>
<td>16%</td>
<td>84%</td>
<td>609</td>
</tr>
<tr>
<td>158</td>
<td>6</td>
<td>6</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>14</td>
<td>9%</td>
<td>91%</td>
<td>948</td>
</tr>
<tr>
<td>128</td>
<td>9</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>3%</td>
<td>97%</td>
<td>1152</td>
</tr>
<tr>
<td>116</td>
<td>12</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>4</td>
<td>3.5%</td>
<td>96.5%</td>
<td>1392</td>
<td></td>
</tr>
<tr>
<td>81</td>
<td>18</td>
<td>3</td>
<td>1</td>
<td>4</td>
<td>1</td>
<td>5%</td>
<td>95%</td>
<td>1458</td>
<td></td>
</tr>
<tr>
<td>35</td>
<td>24</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>100</td>
<td>840</td>
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<tr>
<td>16</td>
<td>30</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>100</td>
<td>480</td>
<td></td>
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<tr>
<td>7</td>
<td>36–45</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>100</td>
<td>252</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(1) CR - Clotted and revised
(2) NF - New fistula
(3) SS - Silastic cannula shunt
(4) VG - Saphenous vein graft

Table II. Indications for the use of saphenous vein grafts

- Primary fistula failure 11
- Inadequate fistula flow 5
- Unsuitable vessels 4
- S/P multiple shunts 2
- Drug addiction 3
- Extreme obesity 2

Table III. Contributing factors to early fistula failure

- Unsuitable arteries or veins ('The Problem Patient') 14
- Excessive dehydration, poor general condition 8
- Outflow obstruction 3
- Major surgery 4
- Aneurysms (true and false) 3

wasting were all unfavourable factors. Excessive dehydration during a too vigorous peritoneal dialysis may precipitate an early failure. An unexplained thrombotic tendency was present in two patients with grossly adequate vessels. The use of systemic anticoagulation was helpful in one of them, in achieving a functioning vascular access site.

There were 25 late fistula failures (Table I) occurring six months to 18 months following construction of the fistula. If these failures are seen as a ratio to the number of dialysis months, the incidence of failure is really extremely low, even when expressed as the percentage of patients treated, the incidence is again 9%, 3%, 3.5% and 5%, far below the failure rate in shunts in comparable length of use. The contributing factors to late fistula failure are listed in Table IV. Major factors in nine patients were 'medical'
Table IV. Contributing factors to late fistula failure

'Medical' complications (UGI bleeding, hypotension, cardiac arrest, excessive dehydration, pneumonia) 9
Aneurysms, trauma 5
Infiltration 2
Major surgery 4
Inadequate flow 4
Coil rupture

complications like massive upper GI bleeding, periods of hypotension, cardiac arrest, excessive dehydration, pneumonia or other systemic diseases. Other factors include aneurysm formation in five patients; infiltration and again in two patients major surgery, mainly bilateral nephrectomy being performed for the control of hypertension; in four patients the flow became inadequate following sclerosis of the vein, endophlebitis and perivenous infiltration. Coil rupture with sudden fall in blood pressure was responsible for the failure in one patient.

In the 27 patients in whom saphenous vein grafts were used for establishment of an arteriovenous fistula, the early and late failures were related to similar causes as have been outlined for the standard A-V fistula. In general, a saphenous vein graft once successfully established is just as satisfactory as an arteriovenous fistula. However, it is more time consuming, more traumatic to the patient and associated with more morbidity and discomfort. We feel that a vein graft should be performed only in those patients in whom a fistula cannot be done or has failed, and not as a procedure of choice like some have advocated.

PREVENTABLE MEASURES

Based on our experience one can clearly define some measures which, if taken, may help reduce further the incidence of early or late failure (Table V). A thorough examination of the extremity with a venous tourniquet prior to fistula construction will help prevent some of the early failures. The entire course of the cephalic vein should be examined to ensure proper outflow. Very frequently the cephalic vein will be adequate at the wrist level.

Table V. Preventable measures

Examine for open outflow
Avoid excessive dehydration postoperatively
Avoid fistula construction in the very sick patients
Special attention during major surgery
Consider proximal fistula in patients with advanced sclerosis
Prevent aneurysm formation
since this is not the level used for repeated venipuncture or intravenous injections. However, the vein may be thrombosed proximally and this can be detected easily when the venous tourniquet is on. The vein should be examined and followed in its course from the wrist to the elbow and the patency can be easily ascertained on physical examination by percussion of the vein and feeling the percussion wave at the elbow in the antecubital vein. One should examine both upper extremities and perform the operation in the arm in which the conditions are more favourable. If the outflow at the elbow is obstructed, a saphenous vein graft should be used instead, since any fistula constructed in a vein in which a high resistance is evident before or during surgery is doomed to failure. Immediately following construction of the fistula, excessive dehydration should be avoided since this is the major factor in early fistula failure. Fistula construction should be avoided in the very sick patient, especially in the patient who is unstable haemodynamically, has pericarditis or is severely ill with some other medical complication. The silastic cannula shunt is the preferred method of access to these patients. This can be done in the lower extremity, thus not losing any fistula site for future use. If a patient with an arteriovenous fistula has to undergo unrelated surgery like bilateral nephrectomy, special attention should be paid to the fistula arm, any pressure in this area should be avoided and any dehydration or hypotension during surgery corrected. If the fistula clots soon after surgery, de-clotting should be done promptly and this is usually accomplished without difficulty. In the diabetic patient, in whom there is heavy calcification of the vessels at the wrist level, the fistula may be constructed more proximal in the forearm where arterial flow is usually better. Fistulae between the brachial artery and the antecubital or cephalic vein have not functioned well in our hands, although other groups have used them successfully. Out of three fistulae constructed at this level, two had to be closed because of severe arterial insufficiency with ischemia of the median nerve which developed in two patients. Prevention of aneurysm formation would also prevent some of the fistula failures and this can be accomplished by not constructing fistulae proximal to a venous obstruction or in a vein which has high venous resistance, avoiding repeated needling of the arterised vein in the same site, thus causing localised weakness of the vein wall and aneurysmal dilatation; proper control of bleeding following end of dialysis will help avoid false aneurysm formation.

In some patients modifications will have to be used if for any reason either a subcutaneous arteriovenous fistula or a saphenous vein graft cannot be accomplished successfully. Some of the more unusual procedures performed in this group of patients are listed in Table VI. This includes use of the vein graft for silastic cannula shunt. This was a patient in whom multiple shunts had been done on both upper extremities. She had been on dialysis
Table VI. Modifications of standard procedures

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use of vein graft in silastic cannula shunt</td>
<td>1</td>
</tr>
<tr>
<td>Vein-to-vein bypass</td>
<td>1</td>
</tr>
<tr>
<td>Artery-to-artery bypass</td>
<td>1</td>
</tr>
<tr>
<td>Brachial artery fistula</td>
<td>3</td>
</tr>
<tr>
<td>Cannulation of brachial artery and vein</td>
<td>1</td>
</tr>
<tr>
<td>Axillary artery to brachial vein bypass</td>
<td>1</td>
</tr>
</tbody>
</table>

for more than six years. The whole length of the radial and ulnar arteries had been used in both upper extremities. Therefore a saphenous vein graft was used bringing blood flow from the brachial artery in the arm down to the forearm and a Scribner shunt was inserted using this vein graft as the arterial inflow. In this particular patient a Scribner shunt had to be used since she was on home dialysis and her husband was unable to use the fistula, although the patient did have a successful fistula. In a second patient, a vein-to-vein bypass was used to bypass a proximal venous obstruction; the brachial artery and the antecubital vein were used for fistulae in three patients and as mentioned before only in one of them has this been used successfully for more than a year with the patient remaining asymptomatic; in one patient the brachial artery and the vein were used for silastic cannula shunt in the arm; and in one patient an artery-to-artery bypass was used. Surgical ingenuity may be tested in these cases and one should be familiar with various modifications to the standard procedures. We have not used homografts or heterografts since we have not found this to be necessary. Recently in one diabetic patient, the axillary artery was used as a source for inflow for a vein graft from the axillary artery to the brachial vein, which was placed subcutaneously in the arm and was used successfully for dialysis.

SUMMARY

Experience in achieving vascular access for haemodialysis in 214 patients is presented, with detailed analysis of early and late failures for a period ranging from 3 to 44 months. Contributing factors of early and late failures have been identified and preventable measures may further reduce the early and late failure rates. A satisfactory access for haemodialysis can be established in all patients in which this is required, regardless of age, systemic disease and venous or arterial factors.
OPEN DISCUSSION

R L LAWTON (Iowa City): I would like to ask the speaker if he has had any experience with fistulae post-transplant? It has been my experience that over 50% of them closed without use.

HAIMOV: Yes, we have had the same experience. Many of them will clot by the same mechanisms that I think they clot following bilateral nephrectomy. The trauma of surgery, probably some hypercoagulable state which follows any major procedure, will predispose the fistula to close. Most of the fistulae following transplant close spontaneously, we did not have to close any of them.

LAWTON: I would like to make a comment on your end to side fistula at the wrist. It has been our experience after having constructed a considerable number that occasionally you get a steal syndrome distal to the communication (see page Editors). One of the reasons is that you have an area of low resistance, and the circle between the ulnar artery and the radial artery acts as a drain from the digits and you will actually get a steal syndrome if the fistula is significant. Have you encountered this steal?

HAIMOV: I think theoretically you are perfectly right, but in practice it did not turn out to be a problem. In a significant number of patients we have had no arterial insufficiency of the hand develop in any because of a steal. It did develop with the brachial artery fistula and, as I said, we had to close two because of this problem.

R RIGOLOSI (USA): Have you had any experience with leg fistulae?

HAIMOV: No.

W R CATTELL (London, Chairman): Has anyone in the audience any comment to make on leg fistulae?

M McGOWEN (Belfast): We have a thigh fistula which has functioned satisfactorily for a year and the patient can needle it himself. We are considering using further leg fistulae.
PART 5
ROUND TABLE DISCUSSIONS
Dialysis and Transplantation in Children
Chairman: K Schärer
Heidelberg
GFR
Access to Blood Stream for Dialysis
Chairman: S Shaldon
London
England, UK
Hepatitis
Chairman: H J Goldsmith
Liverpool
England, UK