ACCESS TO CIRCULATION BY PERMANENT ARTERIOVENOUS FISTULA IN REGULAR DIALYSIS TREATMENT

J. S. HANSON, M. CARMODY and B. KEOGH

Department of Urology and Renal Unit, Jervis Street Hospital, Dublin, Ireland

Regular Dialysis Therapy (RDT) has now become accepted therapy for the treatment of selected cases with end stage renal disease.

Hitherto, repeated access to blood vessels for dialysis was achieved by means of the conventional teflon or teflon-silastic prosthesis establishing an external semi-permanent arteriovenous shunt (Quinton et al., 1960; Hegstrom et al., 1961; Quinton et al., 1962). In spite of its considerable success this technique is far from perfect, and problems of infections and clotting remain as a major cause of trouble in the management of these patients. The average survival rate for external shunts varies considerably from one Centre to another. In a series published from the Swedish Hospital in Seattle, the mean shunt life for both arteries and veins varied from 11 days to 11.4 months (Murray et al., 1964). In a more recent review from the same Centre (Pendras and Smith, 1966) an average cannula survival of 12 to 14 months was reported. This they attributed to the prevention of infection in the patient prior to and shortly after operation, and also to avoiding cannulation in the severely uraemic state. We have been unable to achieve a similar standard of shunt survival since we commenced RDT in November 1964. Our survival rates in arteries and veins were 3.8 and 3.6 months respectively, the majority of the failures occurring in the first six weeks following surgery. The longest surviving shunt was sixteen months. Infection and clotting which were the major causes of our failures were responsible for a high morbidity, and often long periods of immobilisation in Hospital for surgical revision of the cannulas. This was particularly true for those in the lower limbs. The frequent manipulations involved in declotting were also a contributory factor to the psychological fixations which some of these patients developed about their cannulas. Our relative failure with the Quinton type shunt prompted us to adopt the surgically created arteriovenous fistula (AVF) as described by Brescia et al. (1966).

SURGICAL TECHNIQUE

Anaesthetic

Brachial plexus block by the axillary route has been used routinely and has proven very satisfactory. Firstly, the accompanying sympathetic block dilates the blood vessels and prevents vascular spasm until the vein has been denervated by the stripping of its fascia. The sympathetic blockage may lead to free bleeding from the line of incision but this can be controlled by circumferential infiltration around the wound with local anaesthetic containing adrenaline. Secondly, the muscular paralysis enables the patient to lie in comfort with an outstretched arm for prolonged periods. Thirdly, the sensory effects of the brachial plexus block extends well into the postoperative period and the analgesic effect is much appreciated by the patients. Fourthly, when performing this procedure under brachial block it is not necessary to hospitalise the patient. It also can be carried out at a time convenient to the patient and therefore, does not interfere with their normal working hours.
Choice of vessels and site of fistula formation

In the early stages of this project we were presented with patients who had had repeated shunt insertion. Frequently only one or two ulnar arteries remained patent. This does not render fistula formation impossible. Neither does it appear to impair seriously the blood supply to the hand to use a sole remaining main vessel for fistula formation (Table I). New patients introduced to the RDT programme, cause no problem in respect of suitability of artery and vein as they are initially fitted with a temporary “Carmody” Type shunt (Carmody, 1964) leaving a virgin arm for use in fistula formation. When available the radial artery and cephalic vein are used routinely, but as mentioned the ulnar artery and any superficial vein in close proximity may be used. Venae comitantes do not give the flow required in the superficial veins. Using an ulnar artery it is preferable to avoid use of the small superficial veins in the area of the skin creases on the ventral carpal surface. In this situation the skin is tethered to the deep fascia making dissection difficult and increasing the possibility of vessel spasm, due to excessive handling. Again the veins in this area form a branching network; therefore, without ligating some branches it is unlikely that a segment of vessel adequate for fistula formation will be obtained. Finally in association with brachial block there appears to be more superficial bleeding in the area.

In choosing a suitable vein a venous tourniquet is applied and the arm inspected. The availability of a suitable vein really dictates the site of fistula formation, but it is desirable to create it as far distally as possible in the arm to facilitate the future insertion of cannulae and tourniquet application. The depth of the artery from the surface does not mitigate against the use of a suitable vein.

A transverse incision is used routinely. Longitudinal incisions have to be of greater length to provide adequate exposure, and they heal badly. The incision is made at the point of nearest proximity of artery and vein, unless the vein has an excessive number of branches in the area. A segment of vein without branches sufficient for an anastomosis is necessary, as

<table>
<thead>
<tr>
<th>Patient</th>
<th>Duration RDT months</th>
<th>Artery* used</th>
<th>AVF formation</th>
<th>Complications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mrs. C.K.</td>
<td>21</td>
<td>radial</td>
<td>21. 1.67</td>
<td>None</td>
</tr>
<tr>
<td>Mr. C.K.</td>
<td>18</td>
<td>ulnar</td>
<td>24. 1.67</td>
<td>Transplanted 5.4.67</td>
</tr>
<tr>
<td>Mr. F.B.</td>
<td>16</td>
<td>radial</td>
<td>21. 1.67</td>
<td>Right AVF infection and haemorrhage</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>16. 2.67</td>
<td>Left AVF successful</td>
</tr>
<tr>
<td>Mrs. E.O.R.</td>
<td>14</td>
<td>ulnar</td>
<td>31. 1.67</td>
<td>AVF non-function (Quinton shunt replaced)</td>
</tr>
<tr>
<td>Mrs. M.C.</td>
<td>12</td>
<td>radial</td>
<td>10. 4.67</td>
<td>None</td>
</tr>
<tr>
<td>Mr. J.D.</td>
<td>11</td>
<td>ulnar</td>
<td>20. 3.67</td>
<td>None</td>
</tr>
<tr>
<td>Mr. D.M.</td>
<td>10</td>
<td>radial</td>
<td>28.12.66</td>
<td>None</td>
</tr>
<tr>
<td>Mr. J.T.</td>
<td>9</td>
<td>radial</td>
<td>2. 1.67</td>
<td>Left AVF non-function</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>16. 1.67</td>
<td>Right AVF successful</td>
</tr>
<tr>
<td>Miss E.F.</td>
<td>7</td>
<td>radial</td>
<td>23. 1.67</td>
<td>None</td>
</tr>
<tr>
<td>Mrs. E.C.</td>
<td>6</td>
<td>radial</td>
<td>17. 1.67</td>
<td>None</td>
</tr>
<tr>
<td>Mr. J.D.</td>
<td>6</td>
<td>radial</td>
<td>18. 1.67</td>
<td>None</td>
</tr>
<tr>
<td>Miss S.B.</td>
<td>4</td>
<td>radial</td>
<td>15. 4.67</td>
<td>None</td>
</tr>
<tr>
<td>Mrs. K.K.</td>
<td>3</td>
<td>radial</td>
<td>9. 4.67</td>
<td>None</td>
</tr>
<tr>
<td>Mrs. E.F.</td>
<td>1</td>
<td>ulnar</td>
<td>8. 6.67</td>
<td>None</td>
</tr>
<tr>
<td>Mr. J.McK.</td>
<td>1</td>
<td>radial</td>
<td>14. 6.67</td>
<td>None</td>
</tr>
</tbody>
</table>

* Radial arteries previously cannulated.
it is desirable to leave as many patent tributaries as possible. In the virgin arm the cephalic
vein is constant in position and generally of good calibre, but in patients who have had
repeated shunt insertion and intravenous therapy, most subcutaneous veins may be occluded.
With an adequate cross anastomosis, veins that are quite minute enlarge and it seems that
large thrombosed veins may recanalise. The skin incision should be of sufficient size to
ensure that an adequate segment of vessel may be mobilised without tissue distortion due to
retraction. Caution must be exercised to limit the incision to skin only as otherwise the veins
in the superficial fascia may be severed. Having incised the skin the superficial fascia
is opened as far as the lateral margin of the vein on both sides. The skin and superficial fascia
are undermined on both sides of the wound leaving the vein encased in its own fascia. A
venous tourniquet is applied to dilate the vein. The fascia on the vein is incised down to the
adventitial layer at a central point and a sling is positioned here. From this point the vein is
cleared by sharp dissection. Once the correct tissue plane has been entered it is quite easy to
clean the vein. To ensure maximum mobilisation adjacent tributaries are cleaned in similar
fashion. Another sling is now inserted and the vein is swung to the area of the artery giving
an indication of the degree of mobility and adequacy of dissection. Further dissection may
be necessary. The tourniquet is now released, there now being no danger of vessel spasm in
the segment of vein that is to be used. The fascia over the artery is incised longitudinally. At
one point the artery is freed from the venae comitantes and the sling inserted round the artery;
the artery is dissected free. Only tributaries that will definitely interfere with its mobility are
cut and tied. A second sling is inserted. Using both sets of slings, artery and vein are approx-
imated. Both vessels must lie parallel for a distance of at least 2.5 cm between slings without
tension or angulation, if adequate fistula formation is to be obtained. This is a most critical
point as an equal flow both proximally and distally in the vein will otherwise not be obtained.
Both sets of slings are now replaced with DeBakey peripheral arterial clamps (Fig. 1). These
clamps are introduced from assistant side. Longitudinal incisions 0.5 cm in length are made in
corresponding lateral surfaces of vein and artery. The lumen of both vessels is washed out
with heparinized saline and a side to side anastomosis is made in continuous fashion using
00000 polyethylene. On release of the clamps there is an immediate bruit and thrill. The
wound is sutured in two layers.

Fig. 1.

93
Postoperative care

We feel it is necessary to use prophylactic antibiotics for five days after the operative procedure. It is essential that patients are well dialysed prior to operation, as this greatly lessens the hazard of infection. The fistula is not used for seven days to allow healing and vein distention.

Dialysis technique

Prior to venipuncture a tourniquet is applied to the upper arm to obtain venous engorgement. The puncture sites are infiltrated subcutaneously with 0.5% lignocaine without adrenaline. Initially obtaining a suitable puncture needle was a major problem. We tried a variety of needles, but were continuously faced with the problem of clotting in the lumen of the needles despite increasing the standard dose of heparin by 10,000 Units. However, we soon realised that the quality of our needles was at fault, the surface of the inside of the lumen being rough. We now satisfactorily use a 1.5 inch 14 gauge thin walled smooth bore needle (Bardic). The needles are attached to Tomax extension tubes. Firstly, the return flow needle is inserted cephalically below the antecubital fossa and advanced maximally. The tourniquet is released and the standard dose of Heparin is infused through this needle. Adequate time for heparinisation is allowed. The tourniquet is now reapplied below the proximal needle and the outlet venipuncture is performed. The needle may be inserted cephalically distal to the AVF or proximally with the needle point facing towards the hands (Fig. 2). The predialysis blood samples are taken from this latter tube. A light venous tourniquet is occasionally necessary between the needle insertions to ensure adequacy of flow. This is particularly so in the first few weeks after fistula formation, but later is unnecessary as the veins become distended and arterialised. Blood flow rates of 300 ml per minute are easily obtainable using a roller type blood pump. Each dialysis lasts nine hours and there is no falling off in the blood flow rates. At the completion of dialysis, protamine sulphate is infused. Each needle is removed at intervals of ten minutes and digital pressure is

Fig. 2.
applied by the patient along the line of venepuncture until haemostasis is obtained. This requires three to five minutes on an average. A light dressing is applied to the puncture sites which the patient discards after a few hours.

COMMENT

On our dialysis programme we use Kolff Twin-Coil Machines, similar to those used by Brescia et al. who pioneered this technique of access to the circulation. In order to maintain an adequate flow rate with this technique some form of pump on the “arterial” side is necessary. In our experience with the external AV shunt (Quinton-Scribner) we must admit that our earlier RDT patients were inadequately dialysed owing to very demanding acute renal failure commitments. For the past six months we have been able to correct this and we recognise that inadequate frequency of dialysis may have increased our incidence of clotting and infection in the original external shunts. We are nonetheless impressed by the Brescia-Cimino fistula which allows much greater comfort and freedom for the patient. One lady on our programme has taken up golf since discarding her external shunt for the fistula.

Since we adopted this method of access to the circulation for haemodialysis, the morale of each patient is considerably changed. The patient no longer lives with all the fears of an artificial teflon shunt with its possible hazards and complications. He can rehabilitate himself more easily and his working hours lost have decreased considerably. Similarly life for members of the Staff is no longer punctuated by frustrating crises of clotted shunts and infection.

We have not observed any evidence of cardiac embarrassment in spite of the alteration in circulatory dynamics produced by the introduction of the AV fistula.

| No. of patients | 15 |
| No. of AVF     | 17 |
| No. of dialysis months | 47 |
| No. of dialysis | 394 |
| Failed AVF     | 3  |

(2 successful repeats opposite limb)

REFERENCES


95
DISCUSSION

BOEN (Amsterdam): I would like to ask Dr. Verberckmoes in particular what is the incidence of failure to puncture the vessels and of failure to initiate dialysis at the scheduled time. Furthermore, what is the incidence in his experience of after-bleeding at the puncture sites?

VERBERCKMOES (Louvain): The incidence of after-bleeding is very small. We had no serious complication of that nature. I would like to show another slide which gives the results of three months during which we noted all puncture failures.

You see that during the period of three months the total number of dialyses with an internal fistula was 343 and we had 277 dialyses without one puncture failure. This is about 81%. In the 19% remaining we had one or more puncture failures and, for the total of 343 dialyses, the number of punctures per dialysis was 2.4%. You will realise that, had all punctures been done without a failure, we should have had a number of punctures per dialysis of two. The actual number was 2.4%. It must be said that this was during the period in which two new patients with new internal fistulas were entering into the programme—I agree with you that, in the first weeks of dialysis, you may have some quite difficult punctures.

O'SULLIVAN (Cork): I have had experience with only two of these fistulas. The first one was a side to side anastomosis which worked quite well and the second one gave me difficulty in getting the vein to approximate so I did an end to side anastomosis—cut the vein and did an anastomosis with the side of the artery. This worked quite efficiently and, I think, is just as good if you have any problem with side to side anastomosis.

The other problem with bleeding when the needles are removed is not to remove the afferent needle which is going into the artificial kidney, until you have returned all the blood from the kidney back into the patient, because the pressure within the veins seems to be much higher during the time the blood is returning and we found that if we pulled the first needle out we ran into bleeding under those circumstances.

LINDSTEDT (Lund): I should like to ask if anyone knows how the flow is in the region of the fistula—if the blood goes out through the distal end of the radial artery or if the fistula steals blood from the proximal end of the radial artery? I prefer to make the end to side anastomosis between the artery and the vein if there is any difficulty in approximating the artery and the vein in the wound.

ROBSON (Petah Tiqva): During a limited experience of these fistulas, we have noticed that the patients have to have close supervision during the dialysis because any slight movement of the arm will result in a reduction of the blood flow. It is all very well to do these fistulas during a daily dialysis when the nursing staff and the doctors can closely supervise the patient, but we have not as yet tried them on overnight dialysis and I wonder if any of the speakers here have had experience of using these internal fistulas in overnight dialysis?

VERBERCKMOES (Louvain): I think that the risk of trouble during dialysis with the needles is much less when one uses polypropylene catheters, instead of metal needles. I have no experience with overnight dialysis, but during dialysis we had no major troubles from, for instance, extravasation of blood during dialysis.

BERLYNE (Manchester): We have had experience of one patient on overnight dialysis and this was quite an unpleasant experience, with repeated requirement for nurse aid. In our experience, patients dislike these multiple punctures and I am surprised at the speakers who say that patients prefer this puncture technique to the standard Scribner-Quinton technique.
DISCUSSION

RAE (Seattle): Although nobody thinks that the Scribner shunt is a perfect bit of equipment and there are many disadvantages, I think one of the biggest disadvantages of the internal a-v shunt is that it cannot be used for home dialysis and the patients must be dialysed in a centre. I would like to know two things: firstly, have any groups tried to teach the spouses of these patients to put the needles in themselves, therefore permitting them to go home, and, secondly, have any groups been able to get adequate flows through this shunt without using a pump?

We would agree, in our small experience of the internal shunt, with Dr. Berlyne. We have one patient on this method at the moment and, although in between dialyses he seems quite happy, when it approaches dialysis time, there is a notable agitation on his part in anticipation of the needling.

MICHELSSEN (Louvain): I think it is extremely important to use local anaesthesia before introducing these needles for the puncture and, if you perform a good local anaesthesia, it is very well tolerated by the patient. I can confirm that we never saw a patient who was dialysed by both techniques who preferred the Scribner shunt, but maybe some doctors prefer the Scribner shunt because it is less work.

VALEK (Prague): I think that the subcutaneous arterio-venous shunt is a real progress. It cannot be used in all patients, of course—for instance, obese patients. The original method is a little complicated and must be undertaken by a vascular surgeon. Moreover, in the side to side anastomosis, a part of the blood flows down out of the shunt. We successfully used a fibrin tunnel for the connection of the artery and the vein (This Volume, p. 359).