PART II

SHUNTS AND FISTULAE
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Clinical Experiences with Multiple Blood Access Sites

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Our regular dialysis programme commenced in 1965, when experience with Scribner shunts was limited in the United Kingdom. As a result, three years later seven out of twenty patients had lost all available peripheral blood access sites, two out of three deaths resulting directly from this. Regular blood transfusion associated with the use of the early Kill dialyser which had a large dead space led to an outbreak of serum hepatitis in 1966, which involved many patients, their relatives and the staff of the Unit. For this reason it became Unit policy to transfer all our existing patients to home dialysis and to use our hospital facilities purely for home dialysis training and back-up purposes. On epidemiological grounds it became essential to reduce hospital readmission for shunt failure in these infective patients to a minimum. The Cimino-Brescia fistula appeared to be the answer to our problem.

Our initial experience with the fistula in a total of twenty-two patients on home-dialysis was not encouraging; in a large proportion of the patients the number of forearm vessels suitable for fistula formation was restricted by previous shunt surgery. The use of small veins often led to failure to form a functioning fistula, or to the development of a leash of tortuous veins which were difficult to puncture. We now realise that our earliest fistulae were made too close to the wrist-joint and that, for fear of inducing left ventricular failure, we made the anastomosis too short, often using smaller veins than necessary.

At this stage a review of our policy led to the following conclusions:

(1) Whenever possible the upper limbs would be reserved for fistulae.
(2) The elective fistula site would be 8-10 cm above the wrist, using the largest available vein with a 1 cm anastomosis, side to side, without distal ligation of either vessel. If necessary, blood flow through the fistula could be improved later by the creation of a second anastomosis, fashioned side to side, thus preserving the blood supply to the hand.
(3) In home dialysis patients with a less than excellent fistula, the possession of an alternative access site would lead to a reduction in emergency readmissions for blood-access problems, thus reducing the risk of hepatitis dissemination.

(4) The combination of a shunt and fistula would simplify the training of the patient's spouse in the insertion of the fistula needles. In addition, hospitalisation for fistula training could be reduced to between six and eight weeks, a shorter time than the common incubation period of serum hepatitis.

Various combinations of access sites were used, the most satisfactory being a radial artery fistula in both forearms. Other combinations included a forearm fistula together with shunts in various sites; or two fistulae in the same forearm, either radial and ulnar or double radial anastomoses.

Our experience in fifteen patients with two or more access sites ranges from three to twenty-one months, totalling 181 patient-months (Figure 1).

![ACCESS SITES](image)

Figure 1. Access site statistics

In addition, five patients had a third access site totalling forty-two patient-months. Following these changes of policy, home dialysis, using multiple access sites has been successful, eliminating entirely hospital re-admission for blood access problems. In turn, this has resulted in increased confidence on the part of the patient and a greatly reduced cross-infection risk to our hospital staff.

Out of seventeen patients, five now have one excellent fistula, and twelve
two fistulae graded as satisfactory.
Both local and cardiovascular complications have occurred.

LOCAL COMPLICATIONS (Table I)

An occasional haematoma is inevitable. Five patients previously well established on fistula dialysis, have required medical help at home as a result of haematoma formation or repeated mispuncture. This is potentially dangerous if the patient has only one fistula. The presence of an alternative access site allows the affected arm to be rested.

<table>
<thead>
<tr>
<th>Table I. Local Complications of Fistulae</th>
<th>Number of Occurrences</th>
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<tbody>
<tr>
<td>(1) Large Haematomata</td>
<td>5</td>
</tr>
<tr>
<td>(2) Late Thrombosis</td>
<td>5</td>
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<tr>
<td>(3) Serious Infection</td>
<td>1</td>
</tr>
<tr>
<td>(4) Uncontrollable Haemorrhage</td>
<td>1</td>
</tr>
<tr>
<td>(5) Dermatitis</td>
<td>1</td>
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</tbody>
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Four of our patients with satisfactory fistulae have thrombosed these on five occasions due to:

1. Repeated needling of a fistula segment leading to local stricture
2. Sixteen punctures along the course of the fistula on two successive dialysis nights
3. Application of a tight bandage associated with post-dialysis hypotension
4. Generalised vasculitis
5. Uncertain cause.

One fistula required ligation following septicaemia associated with repeated bleeding from an infected puncture site.

One case of eczematous allergy, possibly to the iso-propyl alcohol of the 'Medi-Swab' used for disinfection of the skin, was observed, which responded to a change to 1% Hibitane Cream.

CARDIOVASCULAR COMPLICATIONS
The effects of arteriovenous communications on the cardiovascular system have been a source of concern since the introduction of the Cimino-Brescia fistula. Measurements of cardiac output by dye dilution methods following fistula formation have shown increases in the range of one-half to two litres per minute (Fabian et al, 1970; Round Table Discussion, 1968). Flows of this order are well tolerated by a normal heart, but in dialysis patients the situation may be complicated by anaemia, hypertension, metabolic defects
and the tendency for the flow through the fistula to increase with time.

With two or more arteriovenous communications, the possibility of cardiac decompensation is obviously increased.

In our group, cardiac complications occurred in six of fifteen patients who complained of increasing orthopnea and had clinical signs of left ventricular failure. All six were found to have a haemoglobin of 6.5 g/100 ml or less and four had diastolic blood pressures over 110 mm. Five patients responded satisfactorily to routine treatment, which included digitalis and advice on fluid or salt intake. Three remained ambulant, one required bed rest at home, and two were sufficiently ill to need hospital admission. In one case control was achieved only after the removal of the second access site, a large femoral shunt.

![Cardio-thoracic ratio](image)

**Figure 2.** Effect of multiple access sites on cardiac size

A comparison of chest X-rays taken before and after fistula formation showed that our patients could be divided into two equal groups (Figure 2). In one, the cardio-thoracic ratio tended to increase, whilst in the other it remained constant or decreased. In general terms, patients in the second group are those who have remained well during the observation period.

Although serial chest X-rays provided some information, we felt that it would be advantageous to use a more direct means of monitoring cardiovascular performance, since changes in the cardio-thoracic ratio did not per se indicate clinical cardiac decompensation.
Cardiac output can be measured directly by dye dilution or other methods, but the procedure is uncomfortable for the patients, requires specialised apparatus, and is not entirely free from risk. We therefore decided to investigate the value of an indirect assessment of cardiac function based upon measurement of the time intervals of left ventricular systole.

The potential usefulness of this information as an index of ventricular performance has been known for many years, and a number of workers have shown that left ventricular failure is associated with significant changes in one or more of these time intervals (Weissler et al, 1961, 1968). The technique used followed the routine practice of the adjacent Liverpool Regional Cardio-Thoracic Unit so that comparisons could be made with data obtained from normal and abnormal subjects.

Simultaneous recordings were made of the electrocardiogram, phonocardiogram, apex cardiologygram, and the right carotid pulse-wave, using a Cambridge oscilloscopic recorder running at a paper speed of 10 cm/second.

From these tracings the following time intervals were measured (Figure 3)

1. The total period of electro-mechanical systole 'A' defined as the interval between the onset of the Q wave of the electrocardiogram and the first high frequency component of the aortic second sound.

![Figure 3. Phonocardiogram, apex cardiologygram, right carotid pulse wave and ECG recorded simultaneously (see text)](image-url)
2. The left ventricular ejection time 'B' measured from the beginning of the carotid upstroke (U) to the nadir of the carotid incisura.

3. The interval 'C' from the beginning of the upstroke of the apex cardiomgram (U') to the onset of the carotid upstroke).

4. The pulse transmission time to the carotid artery 'D' measured from the first high frequency component of the aortic sound to the nadir of the carotid incisura.

The pre-ejection period can be calculated by subtracting the left ventricular ejection time 'B' from the total period of electromechanical systole 'A'. This is the same as the interval C minus D in Figure 3.

These intervals were taken as the mean measurements made on five successive cardiac cycles.

The method has proved to be easily repeatable, well accepted by the patient, and since no blood sampling is involved, can be safely used in subjects who are SH antigen positive. Measurements have been made so far only on patients with long-standing arteriovenous communications and are therefore of limited value. The results obtained are, however, of interest when compared with those of a similar study carried out by Fabian et al (1970) on patients following acute myocardial infarction. They showed, as Weissler had done, that there was a positive correlation between the left ventricular ejection time and stroke volume. In their patients with left ventricular failure or cardiogenic shock, the ejection time was initially always less than 250 milliseconds, but rose towards normal as left ventricular failure improved.

![Graph showing correlation between LVET and heart rate](image)

**Figure 4. Left ventricular ejection time and heart rate in 13 patients on regular dialysis with multiple access sites**

A–B Regression line based on 50 normal subjects

\[ \text{LVET} = 392 - 1.5 \text{ hr.} \]

\[ r = 0.82 \text{ s.d. } \pm 12 \]
In our series of 13 patients (Figure 4), three with low ejection times also had clinical left ventricular failure. All but one of the remaining patients had ejection times within the normal range, in keeping with their clinically satisfactory cardiovascular status. The exception was a patient known to have free aortic regurgitation plus a large fistula who might, therefore, be expected to have a high cardiac output. Since only single observations are as yet available, a full analysis of this data has not been made. Future patients accepted for dialysis will have recordings made at regular intervals starting before the first fistula is made and subsequently if their cardiac status deteriorates.

It is hoped in this way to assess the relative importance of factors, such as uraemia, hypertension and anaemia, as well as fistula flow, on changes in cardiovascular performance.

SUMMARY

Early experience of multiple access sites suggests the following conclusions:

A patient is best served by one large, reliable, easily punctured fistula.

Should this ideal not be achievable, the retention of an external shunt with a fistula will facilitate the changeover from hospital to home. Subsequently, such a patient is best served by two fistulae, preferably one in each forearm. The existence of a second fistula will eliminate the need for emergency hospital readmission for access problems, a matter of great importance when hepatitis is threatening the future of dialysis. The presence of multiple access sites does, however, limit the tolerance for dietary and other indiscretions.

In patients with a less than excellent fistula, a second fistula should be created once hypertension and anaemia are corrected.

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REFERENCES


