CHRONIC HAEMODIALYSIS USING THE TWIN MINICOIL KIDNEY

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Two Minicoil kidneys (Lawson, Blainey and Dawson-Edwards, 1962) connected in parallel have been adapted for the treatment of chronic renal failure by twice weekly haemodialysis. The second Minicoil was found necessary in order to double the efficiency of dialysis so that the patients could be fitted into an overnight programme. The unit is assembled and monitored by nursing staff and requires little supervision.

MATERIAL AND METHOD

Three patients with chronic renal failure are being treated (Table 1). To date a total of 150 dialyses have been performed. The three patients have been dialysed using Scribner type arteriovenous shunts (Quinton, Dillard, Cole and Scribner, 1962). The original Minicoil has been modified and is now used free standing (Figs. 1 and 2). The suspension sail, the integral venous bubble catcher and the constant pressure device on the dialysis fluid outflow line have been removed. Negative pressure exerted by the siphon effect of the dialysis fluid outflow line, collapses the P.V.C. envelope around the coil (Mitchell and Blackmore, 1964). This results in improved perfusion with dialysis fluid and increased efficiency. Spacers have been inserted at each end of the coil to prevent the tightly collapsed P.V.C. envelope from cutting off the flow of dialysing fluid.

Both the blood and the dialysis fluid circuits are arranged in parallel and a single bubble catcher without filter is used in the venous line (Fig. 3). The combined surface area of the cellophane membrane is 0.9 square metres and the total volume of the blood circuit is only 400–500 ml. Before dialysis the coils are primed with normal saline which is run to waste as the patient is bled into the coils at onset. After dialysis the blood in the coils is washed back

<table>
<thead>
<tr>
<th>Patient</th>
<th>Age</th>
<th>Sex</th>
<th>Diagnosis</th>
<th>Creatinine clearance (ml/min.)</th>
<th>Daily urinary volume (ml)</th>
<th>Duration of treatment (months)</th>
</tr>
</thead>
<tbody>
<tr>
<td>W.B.</td>
<td>32</td>
<td>M</td>
<td>Polycystic kidneys</td>
<td>1.4</td>
<td>150</td>
<td>9</td>
</tr>
<tr>
<td>C.R.</td>
<td>26</td>
<td>F</td>
<td>Pyelonephritis</td>
<td>0.5</td>
<td>500</td>
<td>6</td>
</tr>
<tr>
<td>R.A.</td>
<td>41</td>
<td>M</td>
<td>Glomerulonephritis</td>
<td>1.2</td>
<td>250</td>
<td>3</td>
</tr>
</tbody>
</table>

W.B. was treated with the Kolff artificial kidney for 2 months prior to transfer to the Twin Minicoil.
into the patient using a litre of normal saline. The average blood loss into the coils has been 90 ml per dialysis. Recently, using an improved washback technique this has been reduced to 30–40 ml. Blood flow rates of 50–100 ml/min. are possible with self perfusion and although we have used this method, it is now our usual practice to pump on the arterial line increasing the flow rate to 150 ml/min. in order to improve the clearance (Fig. 4). A twin track roller pump is used to ensure even perfusion of both coils. Heparin is added to the arterial line at a rate of 2,500 units per hour using a constant infusion pump.

The dialysis fluid is stored in a 750 litre rigid polythene tank at 41°C. and is circulated through a header tank from which fluid flows by gravity to the Minicoils. A single pass system is used with a total flow rate of 500 ml/min. Flow rates greater than this do not substantially increase the clearance (Fig. 5). Ultrafiltration is obtained by adding dextrose (4–20 g/litre) to the dialysis fluid (Fig. 6).

The average duration of dialysis is 15 hours and the patients are treated overnight twice weekly.

RESULTS

Biochemical

The clearances of the Twin Minicoil kidney for urea and creatinine at various blood flow rates are shown in Fig. 4, and for different dialysis fluid flow rates in Fig. 5. All clearances were done in vivo and calculated using either arterio-venous differences or bath water concentrations. Blood flow rates were estimated by measuring bubble transit times.
Fig. 2. Details of layout of Twin Minicoil kidney.

Fig. 3. Twin Minicoil dialysis circuit.
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Table II shows average pre- and post-dialysis serum urea, creatinine, uric acid and phosphate levels for the individual patients. Fig. 6 shows the fluid removed by ultrafiltration with various concentrations of dextrose.

TABLE II

<table>
<thead>
<tr>
<th>Patient</th>
<th>Body weight (kg)</th>
<th>Urea (mg/100 ml)</th>
<th>Creatinine (mg/100 ml)</th>
<th>Uric acid (mg/100 ml)</th>
<th>Phosphate (mg/100 ml)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre dialysis</td>
<td>Post dialysis</td>
<td>Pre dialysis</td>
<td>Post dialysis</td>
<td>Pre dialysis</td>
</tr>
<tr>
<td>W.B.</td>
<td>70</td>
<td>180</td>
<td>84</td>
<td>10.8</td>
<td>6.9</td>
</tr>
<tr>
<td>C.R.</td>
<td>55</td>
<td>150</td>
<td>51</td>
<td>11.6</td>
<td>5.9</td>
</tr>
<tr>
<td>R.A.</td>
<td>75</td>
<td>136</td>
<td>59</td>
<td>13.9</td>
<td>8.4</td>
</tr>
</tbody>
</table>

Fig. 4. Random in vivo clearances of urea and creatinine plotted against blood flow at an average dialysis fluid flow rate of 500 ml/min. Each point on the graph is the average of the designated number of determinations.

TABLE III

Average pre-dialysis packed cell volume (P.C.V.) and transfusion requirements. Also shown is the blood loss into the coils and the blood removed in sampling for investigations.

<table>
<thead>
<tr>
<th>Patient</th>
<th>Average pre-dialysis P.C.V.</th>
<th>Average blood replacement (ml/month)</th>
<th>Average blood loss (investigations) (ml/month)</th>
<th>Average blood loss (into coils) (ml/month)</th>
</tr>
</thead>
<tbody>
<tr>
<td>W.B.</td>
<td>27%</td>
<td>2,000</td>
<td>320</td>
<td>700</td>
</tr>
<tr>
<td>C.R.</td>
<td>26%</td>
<td>1,500</td>
<td>320</td>
<td>700</td>
</tr>
<tr>
<td>R.A.</td>
<td>23%</td>
<td>2,000</td>
<td>320</td>
<td>700</td>
</tr>
</tbody>
</table>

Recently an improved wash-back technique has reduced the blood loss into the coils to 250–300 ml/month.
Fig. 5. Random in vivo clearances of urea and creatinine plotted against dialysis fluid flow rate at an average blood flow rate of 150 ml/min. Each point on the graph is the average of the designated number of determinations.

Fig. 6. Loss of weight in kg/15 hour dialysis plotted against dextrose concentration in the dialysis fluid. Each point on the graph is the average of the designated number of determinations. The average pressure at the venous bubble catcher was 25 mm Hg.

Haematological
Average pre-dialysis P.C.V.'s for the three patients are given in Table III, together with monthly blood transfusion requirements and blood losses.
Clinical

Since starting the programme 6 months ago, there have been no deaths. All the patients have shown a remarkable improvement in their well being. Oedema and hypertension have been controlled by sodium and water restriction together with ultrafiltration during dialysis. In no case has it been necessary to use hypotensive drugs. The average weight gain for the three patients has been 6 kg following initial reduction in weight required to control hypertension. All patients have shown an increase in total body fat as estimated by fat fold measurement (Fletcher, 1962). This, together with the absence of oedema, suggests that this is an increase in real body weight. There are no signs of peripheral neuropathy on clinical examination. One patient, C.R., who had amenorrhoea for one year prior to dialysis is now menstruating regularly. C.R. is completely rehabilitated and her arm shunt has given no trouble in six months. The other two patients with leg shunts have had numerous episodes of clotting and several recannulations, which has precluded them from obtaining suitable work.

DISCUSSION

The Twin Minicoil has all the advantages of a sterile disposable coil kidney. However, when compared with the modified two layer Kiil kidney, the cost of the coils (£9 per dialysis) is relatively high. This is partly offset by the fact that no preparation of the actual dialyser unit is required, resulting in a considerable saving of labour. Increased demand, together with improved design and production techniques, should enable the cost to be reduced.

In our experience the use of a blood pump does not adversely affect the safety of dialysis providing monitoring is adequate.

The transfusion requirements to date, 1500–2000 ml/month, compare favourably with other reported series (Lindholm, Burnell and Murray, 1963) but should be substantially reduced in the future by the use of an improved wash back technique and less blood sampling for investigation. The high figures quoted for blood loss due to sampling have been necessary during the initial investigation of the system.

It is still too early to assess the results of this new technique. However, the absence of peripheral neuropathy, arthropathy or any of the other features associated with the inadequate dialysis syndrome (Baillod et al., 1965) leads us to believe that this will prove to be a satisfactory method of chronic haemodialysis. In addition, the biochemical control achieved is comparable with that reported in other series using the Kiil kidney (Lindholm et al., 1963; Murray, Pendras, Lindholm and Erickson, 1964).

The outstanding advantage of the Twin Minicoil is the ease and simplicity of preparation. The coils are sterile and can be assembled in a few minutes by the nursing staff or patients. This makes it especially suitable for home dialysis and development along these lines is in progress.

Summary

The results of 150 dialyses on three patients with terminal chronic renal failure using the Twin Minicoil artificial kidney are described.

The modified Minicoil and blood lines are obtainable from: Messrs. Capon Heaton Ltd., Hazelwell Mills, Stirchley, Birmingham 30, Great Britain.

REFERENCES


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