PART VIII

TRANSPLANTATION 3

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THE SIGNIFICANCE OF VASCULAR ANOMALIES IN HUMAN RENAL TRANSPLANTATION

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Summary

In a review of 250 consecutive human cadaveric kidney transplants the primary failure rate of donor kidneys with an anatomically abnormal blood supply was 36.7% as compared with 16.2% for kidneys with a single artery and vein (P < 0.001). The incidence of primary failure due to renal vascular thrombosis in the abnormal group was 24.2%, compared with 4.1% in the normal group (P > 0.001). A significantly greater incidence of anastomotic haemorrhage and urinary leak was also associated with an abnormal blood supply in the donor kidney.

Introduction

Multiple renal vessels are present in 25% to 30% of normal human kidneys [1,2]. There is little information concerning the difficulties of transplanting such kidneys although it has been suggested that only kidneys with normal renal vessels of sufficient length (20/30 mm) to enable single arterial and venous anastomoses to be performed without undue difficulty should be used for transplantation [3]. Other authors have transplanted kidneys with multiple renal vessels by performing multiple arterial or venous anastomoses, by ‘fish-mouthing’ renal arteries or by ligating the anomalous artery or vein [4–6].

The object of the present study was to compare the results of transplanting kidneys with abnormal renal vessels with the results of those kidneys with normal vessels.

Materials and Methods

Two hundred and fifty consecutive human cadaveric renal transplants were carried out at the Queen Elizabeth Hospital, Birmingham, between September 1968 and December 1974. The transplant operations were performed by a team of surgeons using a standard extraperitoneal approach to the recipients’
vessels in the iliac fossa. The renal vein was anastomosed end-to-side with the external iliac vein and the renal artery end-to-end with the internal iliac artery or end-to-side to the external iliac artery using 6-0 silk. The ureter was implanted into the bladder using 3-0 atraumatic catgut, employing either a simple two layer closure to the dome of the bladder or a tunnel with anterior cystotomy (Politano Leadbetter) according to the preference of the surgeon. Splintage of the vesico-ureteric anastomosis was not used. Bladder drainage was effected for 10 days by means of an indwelling Foley Balloon catheter.

The case records were reviewed with particular reference to the following:

1. The incidence and cause of primary failure in kidneys with a single renal artery and vein (normal) and kidneys with more than two vessels (abnormal). Primary failure was defined as a transplant that failed to secrete urine or to maintain the recipient without the need for continuing dialysis. Renal vascular thrombosis was diagnosed as the cause of primary failure only when it occurred without any histological evidence of rejection. The diagnosis of rejection was based on cellular intimal thickening in the arteries and arterioles with fibrin deposition in the intima or media coupled with atypical glomerular proliferation, glomerular thromboses or generalised dilatation of glomerular capillaries.

2. Donor information included: donor ventilated or non-ventilated prior to nephrectomy, initial warm ischaemic time (IWIT), cold ischaemic time (CIT), and right or left kidney used.

3. Surgical data included: the anatomy of the vascular supply of the donor kidney, the type of surgical correction of the vascular supply (if performed) and the type of arterial anastomosis performed (end-to-side, end-to-end). The vein test was used at the end of each operation to ensure the patency of vessels.

4. Post-operative complications, anastomotic haemorrhage and urinary leak requiring surgical correction.

Results

Of the 250 transplants 171 kidneys had a single renal artery and vein (normal kidneys), 62 had 3 or more vessels (abnormal kidneys), in 4 cases details of

<table>
<thead>
<tr>
<th>TABLE I. Comparability of Abnormal and Normal Donor Kidneys</th>
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<tr>
<td>IWIT ± s.d.</td>
</tr>
<tr>
<td>CIT ± s.d.</td>
</tr>
<tr>
<td>Ventilated/non-ventilated</td>
</tr>
<tr>
<td>Multiple Tx</td>
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<tr>
<td>PFR due to rejection</td>
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</tbody>
</table>

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the renal vessels had not been recorded and in 13 cases the recipient died in the early post-transplant period.

The 171 normal kidneys and the 62 abnormal kidneys were statistically comparable with regard to initial warm ischaemic time, cold ischaemic time, numbers originating from ventilated and non-ventilated donors, the numbers of first, second and third transplants in each group and the incidence of primary failure rate due to rejection (Table I).

The primary failure rate in the abnormal group (36.7%) was significantly greater than that in the normal group (16.9%) (P < 0.001). The incidence of renal vascular thrombosis as the cause of primary failure was 24.1% in the abnormal group and 4.1% in the normal group (P < 0.001) (Table II). The incidence of renal vascular thrombosis was not affected in either group by the use of the right or left kidney for transplantation.

**TABLE II. Incidence of Primary Failure Rates (PFR) and Complications in Kidneys with Normal and Abnormal Vasculature**

<table>
<thead>
<tr>
<th></th>
<th>Normals</th>
<th>Abnormals</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total PFR</td>
<td>16.9%</td>
<td>36.7%</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>PFR due to thrombosis</td>
<td>4.1%</td>
<td>24.1%</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Anastomotic haemorrhage</td>
<td>1.1%</td>
<td>8.1%</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>Urinary leak</td>
<td>2.3%</td>
<td>8.1%</td>
<td>&lt; 0.05</td>
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**TABLE III. Total Primary Failure Rates and Primary Failures Due to Renal Vascular Thromboses with Respect to the Type of Renal Vascular Anomaly Compared to the Failure Rates in Normal Kidneys**

<table>
<thead>
<tr>
<th>Type of vascular anomaly</th>
<th>Number of transplants</th>
<th>Total primary failure rate</th>
<th>Primary failure rate due to renal vascular thrombosis</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normals</td>
<td>171</td>
<td>16.9%</td>
<td>4.1%</td>
<td></td>
</tr>
<tr>
<td>2 arteries on patch ± polar arteries</td>
<td>20</td>
<td>55%</td>
<td>35%</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>2 arteries fish-mouthed ± polar arteries</td>
<td>14</td>
<td>4.2%</td>
<td>21.4%</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>Polar artery only</td>
<td>16</td>
<td>31.3%</td>
<td>18.8%</td>
<td>&lt; 0.02</td>
</tr>
<tr>
<td>Multiple anomalies</td>
<td>12</td>
<td>25.0%</td>
<td>16.7%</td>
<td>&lt; 0.05</td>
</tr>
<tr>
<td>All abnormals</td>
<td>62</td>
<td>36.7%</td>
<td>24.1%</td>
<td>&lt; 0.001</td>
</tr>
</tbody>
</table>

The abnormal kidneys were divided into four groups according to the anatomical abnormality of the blood supply (Table III). The overall primary failure rates (25% to 55%) and the failure rates due to renal vascular thrombosis (16% to 35%) were similar in the four groups and significantly greater
(P < 0.01) than those of the kidneys with single renal vessels (16.9% and 4.1%) respectively. In particular the incidence of renal vascular thrombosis was not reduced significantly by fish-mouthing of two renal arteries as compared with the use of two arteries on a patch.

Anastomotic haemorrhage occurred in 5 of 62 (8.1%) patients receiving abnormal kidneys as opposed to 2 of 183 patients receiving normal kidneys, 1.1% (P < 0.01). Urinary leak occurred in 5 of 62 abnormal kidneys (8.1%) as opposed to 4 of 171 normal kidneys (2.3% (P < 0.05) (Table II).

The significantly greater incidence of anastomotic haemorrhage and urinary leak in the kidneys with abnormal vessels was not associated with any particular vascular abnormality or its attempted surgical correction or the type of vesico-ureteric anastomosis performed.

Discussion

The transplantation of kidneys with abnormal vasculature is common practice and in the present series no attempt was made to exclude donor kidneys on the basis of anomalous blood supply. Sixty-two of 250 kidneys (25.2%) had an abnormal vasculature, an incidence similar to that found in the general population [1,2]. It has been suggested that right donor kidneys are less easily transplanted than those from the left as the short right renal vein causes technical difficulty [3]. In the present series nearly equal numbers of right and left kidneys were used and the incidence of renal vascular thrombosis was similar in right and left kidneys.

Several methods have been suggested for effecting successful vascular anastomosis in kidneys with double renal arteries including fish-mouthing [5] and the anastomosis of each artery and vein end-to-side with the external iliac vessels [8]. In transplanting 57 kidneys with abnormal vessels no renal vascular thrombosis and only one case of post-operative anastomotic haemorrhage were reported [8]. Our experience is at variance with these results.

In the present series all types of anatomical vascular abnormality were associated with a significantly higher primary failure rate than that of kidneys with a single artery and vein. This higher primary failure rate was due mainly to a six-fold increase in renal vascular thrombosis. No significant differences were found between the kidneys with normal and abnormal vasculature in regard to other factors causing a high primary failure rate including the incidence of non-ventilated donors, multiple transplants, warm and cold ischaemic times and acute rejection [7]. Thus it is concluded that an abnormal renal vascular supply in donor kidneys is responsible for the significant increase in primary failure due to renal vascular thrombosis.

It is of interest to note that kidneys with polar vessels also have a high primary failure due to renal vascular thrombosis and an increased incidence of urinary leak. Two of the five urinary leaks which occurred in the abnormal group were associated with polar arteries.

It is generally considered that tying supernumerary renal veins in renal transplantation is safe, as intrarenal veno-venous anastomoses are numerous. On occasions when multiple renal veins were anastomosed on a patch to the external
iliac vein, there were no renal venous thromboses and only one of renal 
arterial thrombosis, and in this case double renal arteries were also present. 
In 4 kidneys with double veins, one of which had been tied in each case, 2 
developed renal vein thrombosis. These figures are too small to reach statisti-
cal significance but may indicate that the individual anastomosis of multiple 
renal veins is less likely to cause venous thrombosis than the ligation of all 
but one vein.

The complications of anastomotic haemorrhage and urinary leak are signi-
ificantly more frequent in donor kidneys with an anomalous blood supply than 
in those with a single artery and vein and both these complications are asso-
associated with significantly increased mortality and morbidity. In view of these 
findings it seems questionable whether donor kidneys with an abnormal vascu-
lar supply should be used in human cadaveric renal transplantation. If this 
view were accepted, no less than one out of four kidneys removed for the 
purpose of renal transplantation should be excluded.

Acknowledgments

We wish to acknowledge the generous help of Professor D B Brewer who per-
formed the histological examinations of the kidney transplants.

References

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Open Discussion

McMASTER (Cambridge) It is certainly an alarming prospect if we are going 
to lose one in four of our kidneys. We are desperately short as it is. I would 
like to question one or two aspects of this paper. To say that 50% of kidneys 
with renal vein ligations develop renal vein thrombosis is quite out of keeping 
with the experience that we have had over a large number of years. Could I 
ask you a little bit about technique? What preservation methods are you 
using? Multiple vessels can present problems and when machines are being 
used we know that smaller vessels are more likely to intimal damage. Secondly 
if you have multiple vessels on a patch are you really putting them onto the 
internal iliac artery when it is technically so much easier to put them in the 
obvious position on the external iliac artery?
SANSOM Only one of the kidneys used in this series was presented to us on a Gambro machine, if that is what you are thinking about. As far as perfusion fluid after nephrectomy is concerned, we really did not have enough data on all the kidneys to assess whether one particular solution was more likely to lead to thrombosis post-operatively. As far as technique is concerned, there is nothing unusual in our particular technique.

McMASTER Do you use the external iliac artery?

SAMSON The group with arteries on a patch was divided more or less half and half into two groups, one of which was anastomosed onto the internal iliac artery and one on to the external iliac artery. If the surgeon was happy that he could anastomose two arteries on a patch on to the internal iliac artery, he went ahead and did it rather than put it on to the external iliac. There is always a small risk of compromising the lower limb.

McMASTER Could you just comment on this 50% of renal vein thrombosis? That must be a unique experience.

SANSOM This is a very small group; in fact there were really four such kidneys where we had two veins and one artery and in each of these one vein was tied, and just one was anastomosed. In two out of those four a renal vein thrombosis, not arterial, led to the removal of the kidney.

BRYNGER (Göteborg) I must say that I am quite astonished by the high failure rate you have. We have transplanted around 800 cadaver kidneys by now and we have hesitated once or twice for this kind of technical reason. I agree with you that tying lower polar arteries might definitely give a higher urinary leakage rate but we have by no means experienced arterial thrombosis, and in no case a renal vein thrombosis due to ligation of an extra vein. Our routine over the years has been to just ligate the vein if it takes less than 50% of the outflow of the kidney and we have not had your kind of experience.

LINDSTROM (Helsinki) I cannot understand why you are talking about ligating renal veins. It is no problem and we have not seen any thrombosis in these cases. I think you can overcome a big part of these problems. I do not agree with you that you should not use these kidneys. In harvesting kidneys with multiple arteries the artery may be cut off too early. We found out that in the cases with leakage and necrosis of the ureter 50% of these had multiple arteries.

BELL (Leicester) If you have an arterial problem, what you do depends on what you have. I mean that if you have two vessels close together with a patch, then the patch to the external iliac is probably the best thing to do. If they are far apart and equal size I often use the internal iliac artery. If there is a very small superior polar artery it can be tied off. If it is a very small inferior polar artery it needs to be anastomosed and this can be done quite successfully by using the inferior epigastric artery.

SANSOM You say that you can tie a superior polar artery without worry?
BELL  A very small one.

SANSOM  Very small polar arteries have been tied and two of the leaks in this series were very small polar arteries. There was an infarct right down to the calyx with a leak and eventual loss of the kidney. I made the point that you cannot just dismiss the polar arteries and not worry about them because they are small. This has been done and two patients have lost kidneys.

BELL  When you have tied the artery off and revascularise the kidney you can see how large the infarct is. A very small one means a very small one!