THE IMPORTANCE OF INITIAL NEPHRECTOMY TO THE SUBSEQUENT FUNCTION OF THE TRANSPLANTED KIDNEY

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Renal transplantation entails handling of the kidney at 3 different stages of the procedure: (1) at the initial nephrectomy, (2) during the intermediate period between nephrectomy of the donor and vascular suture into the recipient (including any storage procedure used), and (3) during vascular suture into the final recipient, i.e. the actual transplantation.

Virtually no handling of the kidney is necessary between the initial nephrectomy and completion of the actual transplantation, and these procedures should not entail traumatic damage to renal parenchyma. During the initial nephrectomy, however, considerable manipulation is usually essential, and must constitute a considerable danger of destruction for the parenchyma.

These experiments were carried out to assess the magnitude of functional damage caused by the initial nephrectomy and to modify the technique used, in an attempt to improve subsequent renal function.

MATERIALS AND METHODS

Adult mongrel dogs, weighing between 35 and 50 lb., were anaesthetized with intravenous pentobarbitone sodium. They were intubated and manually ventilated for the duration of the surgical procedure.

Experimental Groups

Group I. 10 dogs: 4 auto- and 6 homotransplants. In this group, 'ideal' nephrectomy was performed, paying scrupulous attention to the criteria considered important to successful post-transplant function of the kidney.

Group II. 7 dogs, all autotransplants. A routine nephrectomy was performed without unusual care. In none was the kidney deliberately traumatized, nor was there ever interference with the blood supply.

(a) *'Ideal' Nephrectomy (Group I)*

This whole operation was directed at minimal trauma to the kidney during nephrectomy. The procedure was as follows:

1. A right, subcostal, muscle-splitting incision to afford easy access and wide exposure.

2. Non-touch technique for freeing and stripping the kidney from its peritoneal attachments.

3. No traction on (or compression of) the kidney during dissection of the vascular pedicle and ureter.

4. Fastidious dissection of the vessels and ureter, commencing at the hilum and extending distally down to the inferior vena cava, together with exposure of as great a length of renal artery as feasible: during this manoeuvre the kidney was allowed to lie free, assuring patency of venous drainage and preventing compression trauma to renal parenchyma.

5. Extreme caution exercised in the ligation of any hilar vessels and particularly of arterial branches.

6. Simultaneous ligation of renal artery and vein, or of the artery immediately before vein (venous occlusion before arterial ligation is impermissible).

(b) *Routine Nephrectomy (Group II)*

To clarify the technique of nephrectomy used in this group, a fuller explanation follows:

1. The incision and exposure were similar to group I.

2. After incising the peritoneal covering, this was stripped digitally from the capsule.

3. Pedicle dissection was facilitated by traction on the kidney, which continued during delivery of the kidney through the wound (Fig. 1).

Fig. 1. Traction on the kidney to expose the renal pedicle, (note finger compression of renal parenchyma).

4. No hilar branches were ligated.

5. The renal artery was ligated just before occlusion of the renal vein, never simultaneously.

Transplantation[1]

After cold perfusion[2-4] and capsulotomy[1-4] the renal artery and vein respectively were anastomosed to common carotid artery and external jugular vein—a 'Neck' re-implant.[5] A muco-cutaneous ureterostomy was carefully constructed and the transplanted kidney placed deep to the panniculus carnosus in the dog's neck.

Investigations

Only simple parameters of renal function were investigated: urinary output volume, proteinuria, urinary urea, blood urea nitrogen graft size, survival time and histology.

RESULTS

A. *Survival*

Group	*Number of dogs*	*Number of survivors*
I	10	10
II	7	6

Survival time was selected as 14 days after transplant. All investigations were continued for this period. None of the group I animals succumbed. In group II one died from renal failure after 6 days.

B. *Functional Results (Figs. 2 and 3)*

1. *Urine volume.* In both groups, urine flow was immediate and clear. In group I animals, however, increased volume was apparent from the outset. In both groups there was a prompt response to an intravenous water load. After 7 - 10 days no discrepancy in urinary output volume between the survivors in the 2 groups was observed.

2. *Proteinuria.* Generally, in all transplantation experiments, there is an initial transient proteinuria (a trace to

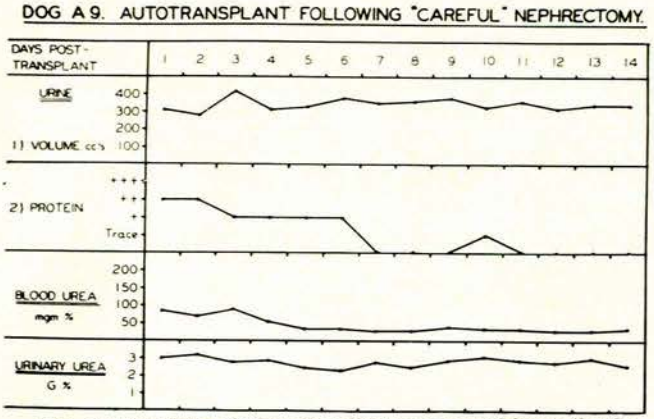

Fig. 2. The kidney is functionally near normal immediately post-autotransplantation, after 'ideal' nephrectomy.

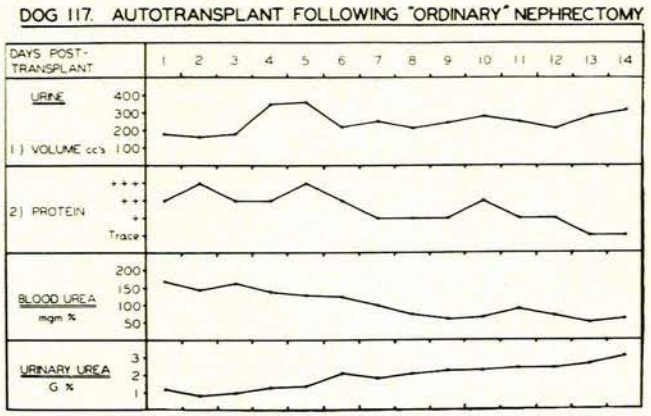

Fig. 3. Deranged renal function following an 'ordinary' nephrectomy. (Note residual abnormality 14 days after transplant.)

+) which is unavoidable, however carefully nephrectomy is performed.[1,6] In group II, proteinuria was gross (++ to +++) and its gradual disappearance protracted. In group I, however, within 3 days of transplantation the quantitative test for urinary protein showed complete absence or only a trace.

3. *Blood urea nitrogen (BUN).* The increase in BUN paralleled almost exactly the reaction to protein in the 2 groups. In group I the transient elevation returned to normal within 5 days, whereas in group II not only were the initial values far higher, but they were persistently in excess of the upper limits of normality, even after 14 days.

Investigation in the group II dog that succumbed showed progressive deterioration of all parameters of renal function. The ultimate BUN values were astronomical.

4. *Urinary urea.* Not surprisingly, these results were closely related to the BUN values, inversely. Urea retention was of far greater magnitude and the return to normal prolonged in group II animals, compared with group I. In some group II animals both BUN and urinary urea were persistently abnormal 3 weeks after transplant.

5. *Graft size.* In group I there was no abnormality of graft size or consistency. Four of the group II kidneys showed definite evidence of size increase for variable lengths of time after re-implantation. In the dog that died, marked swelling was observed at postmortem examination of the transplanted kidney.

6. *Histology.* (*a*) No early histology was available in group I since there was 100% survival for 14 days. Two animals were subsequently sacrificed: both macroscopically and microscopically the picture was indistinguishable from normal.

(*b*) In group II, histology of the transplanted kidney in the only death (4 days after re-implantation) showed extensive subcapsular haemorrhage with extravasation of blood into the renal parenchyma. Interstitial oedema was marked and there was evidence of tubular cell destruction with thrombosis of small vessels in some areas. One animal in group II was sacrificed 18 days after transplant; there was no significant histological abnormality.

DISCUSSION

This series of experiments was directed exclusively at the determination of the functional outcome of the kidneys removed in these 2 sets of circumstances. Although histological examination was carried out, it should be emphasized that no attempt was made to compare the 2 techniques of nephrectomy from this point of view.

No significant difference in the percentage of survival is demonstrated in these 2 procedures and it is pertinent that no routine nephrectomy was deliberately traumatic to the extent of rendering post-transplant survival impossible. However, although post-transplant function following a routine nephrectomy is adequate, the functional results are far inferior to those present after 'careful' nephrectomy.

At first glance the results are obvious, but they acquire greater significance when it is realized that the difference lies not between a deliberately traumatic procedure and a routine one, but between an inordinately careful nephrectomy and a so-called routine procedure.

Prompted by inexplicable poor initial function after transplant, followed by progressive improvement over the next 14 days, the requirements for a correctly performed 'ideal' nephrectomy were sequentially evaluated previously in some 40 procedures. At first ischaemia was felt to be a contributory factor, but this could not be substantiated, either by histological examination or by the prolongation of ischaemic time. Only when the nephrectomy technique was improved were better functional results obtained.

It is alarming that such a marked degree of functional improvement hinges upon relatively simple and minor technical variation. Compression trauma by handling—particularly if the kidney is used as a lever during vessel dissection—has a more marked deleterious effect on the organ than any other single factor.

Some importance has been attached to the simultaneous occlusion of both renal artery and vein.[7] After arterial occlusion, the kidney is virtually exsanguinated owing to the negative pressure of the inferior vena cava. Severe arterial spasm of the intra-renal arterioles ensues, resulting in definite evidence of renal parenchymatous ischaemia after revascularization, post-transplantation. By the simul-

taneous ligation of both vessels, functional capacity is improved.

The importance of the application of these results to clinical transplantation is easily recognizable. Live donor procurement has been of greater functional success than cadaver graft organs.[5] Although ischaemic time plays a major role in the difference, it is obvious that nephrectomy in a live donor is perforce a procedure fastidiously performed. On the other hand, the acquisition of kidneys from cadavers is an emergency procedure where time is all-important. Trauma to the organ in the latter cases is a real danger and, in addition, if the organ is to be stored, the possibility of parenchymatous damage is even greater.

CONCLUSIONS

Nephrectomy is a routine operation frequently performed. For this reason the important role it plays in successful renal transplantation may have been neglected. In relation to successful functional result, however, it is singly the most important stage in the technique of renal transplantation.

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