Strategies for compensating for the declining numbers of cadaver donor kidney transplants

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Abstract

Background. The living-donor and dual kidney transplantation programmes were initiated in the transplantation centre of Münster (TCM) as two approaches to compensate for the declining numbers of cadaver donor kidney transplants after the implementation of the new Eurotransplant Kidney Allocation System (ETKAS). We analysed the outcome of cadaver, living-donor and dual kidney transplantation and their effects on the waiting list in the TCM.

Methods. Between January 1990 and December 2000, 1184 kidney transplants were performed in the TCM. They were subdivided into cadaver, living-donor and dual kidney transplants and retrospectively analysed in terms of the number of kidney transplants performed, waiting time and waiting coefficient. In addition four representative groups were formed to reflect donor origin (I: cadaver kidney transplants allocated by the old ETKAS, \( n = 180 \); II: cadaver kidney transplants allocated by the new ETKAS, \( n = 139 \); III: living-donor kidney transplantation, \( n = 59 \); IV: dual kidney transplantation, \( n = 31 \)) and compared according to graft function (initial diuresis, creatinine, 3-year graft function), patient survival and median waiting time.

Results. After the implementation of the new ETKAS, the number of cadaver donor kidney transplants at the TCM almost halved, but the proportion of living-donor kidney transplantations increased significantly by 12.8% and of dual kidney transplantations by 8.5%. Patients who had received kidneys from cadaver donors allocated by the new ETKAS (group II) had a better survival rate, short- and long-term function but a longer waiting time than in group I (old ETKAS). Patients with dual kidney transplants (group IV) showed the lowest survival and short-term function rate, but had long-term function equivalent to that of cadaver kidney transplants (groups I and II). Patients who had received kidneys from living donors (group III) had the best survival, and short- and long-term function rate as well as the shortest mean waiting time.

Conclusions. Living-donor and dual kidney transplantation proved to be functionally equivalent alternatives and successful strategies for compensating the declining numbers of cadaver donor kidney transplants.

Keywords: dual kidney transplantation; Eurotransplant Kidney Allocation System; kidney allocation; living-donor kidney transplantation

Introduction

In March 1996 a new system for allocating cadaver donor kidneys for transplantation was introduced into the Eurotransplant countries. The objectives of this new Eurotransplant Kidney Allocation System (ETKAS) were to shorten the mean and maximum waiting times for patients, to improve the chances for patients with rare HLA phenotypes and to level out the differing national kidney exchange rates in the Eurotransplant countries. Other objectives included optimal tissue compatibility and optimal transplant survival [1–3].

Whereas the old Eurotransplant kidney allocation system, in use since 1988, was based on a transplantation centre-orientated kidney allocation, i.e. the selection of recipients from the local transplantation centre, given only a certain minimum degree of tissue compatibility, the new ETKAS envisaged a 100% patient-orientated kidney allocation, in which the highest priority was given to the best possible tissue compatibility between donor and recipient—irrespective of the their links with the local transplant centre [4–6].

The introduction of the new ETKAS has led to fundamental structural changes in the transplantation centre of Münster (TCM). Between 1990 and...
March 1996 an annual average of 130 cadaver donor kidney transplantations was performed under the old ETKAS, but after the introduction of the new ETKAS the annual number of cadaver donor kidney transplantations dropped to an average of 80 between March 1996 and December 2000 (Figure 1). Waiting time increased significantly after the introduction of the new ETKAS from an average of 537 days in the period from 1990 to March 1996 to an average of 933 days from March 1996 to December 2000 (Figure 6c and d). Nevertheless, the number of cadaver donor kidneys from the TCM’s local explantation area decreased only slightly, the result being an ‘export’ of almost 40% of all locally explanted kidneys to other transplantation centres (Figure 1).

In response to this development, a living-donor kidney transplantation and dual kidney transplantation programme was initiated at the TCM, with the aim of compensating for the drop in the numbers of cadaver donor kidneys offered by Eurotransplant, because neither the procurement of kidneys from living donors nor the supply of kidneys from marginal donors were subject to allocation by the new ETKAS.

In the present study we have retrospectively investigated our results at TCM using dual kidney transplantation and living-donor kidney transplantation as alternatives to cadaver donor kidney transplantation and as strategies to compensate for the diminishing number of kidney transplantations.

### Subjects and methods

**Study design**

A retrospective survey of all kidney transplant patients over the period from January 1990 to December 2000 was carried out—subdivided into cadaver donor kidney transplants, living-donor kidney transplants and dual kidney transplants—analysing the number of kidney transplants performed, waiting times and the waiting coefficient (a parameter for assessing the probability of receiving a transplant; it is the ratio between the number of patients on the waiting list and the annual number of transplants).

In addition, the outcome of cadaver donor kidney transplants allocated by the old ETKAS (group I, 180 consecutive kidney transplants from January 1993 until June 1994), after introduction of the new ETKAS (group II, from March 1996 until June 1998, n = 139), of living-donor kidney transplants (group III, from April 1996 until December 2000, n = 59) and dual kidney transplants (group IV from April 1996 until December 2000, n = 31) at 3-year follow-up was analysed (Figure 2). In the above named four groups the waiting time (defined as time elapsing between registration with Eurotransplant and kidney transplantation), survival rate, short-term graft function (defined as initial diuresis on the first day, primary non-function = urine output < 500 ml) and long-term graft function (defined as no need for haemodialysis) was compared. In groups I–IV we performed patient selection in the most possible representative way, in the form of consecutive renal transplantations performed by a uniform surgical technique, as a rule by a single operator (high case load) and, if possible, forming roughly comparable group sizes.

#### Cadaver donor kidney transplantation (old ETKAS)

Group I comprises 180 patients who received cadaver donor kidney transplantations between January 1993 and June 1994, which were allocated by the old ETKAS (Figure 2). Kidney transplantation was performed via pararectal extraperitoneal access on the contralateral side to the kidney with anastomosis of the renal vein to the external iliac vein and of the renal artery with an aortic patch to the common iliac artery. If the bladder musculature was not greatly thickened, the ureter was anastomosed directly to the bladder roof, but if the bladder wall was thickened and hypertrophied we...
performed a Grégoire antireflux operation. In 97% of the cases we used triple drug immunosuppression based on cyclosporin A, and in 3% of cases based on tacrolimus, both in combination with a proliferation inhibitor (azathioprine or mycophenolate mofetil). Immediately before reperfusion we gave additional cortisone therapy in a standard dosage of 1 g, tapering off in accordance with subsequent kidney function and rejection reactions.

**Cadaver donor kidney transplantation (new ETKAS)**

Group II comprises 139 patients who received cadaver donor kidney transplants between March 1996 and June 1998, i.e. after implementation of the new ETKAS. Surgical technique and postoperative care were the same as for group I. Cyclosporin A-based immunosuppression was used in 77% and tacrolimus-based immunosuppression in 23%.

**Living-donor kidney transplantation**

Group III comprises 59 patients who received living-donor kidney transplants between April 1996 and December 2000. In this study there were 15 donor–recipient pairs without any blood relationship, while 44 donor–recipient pairs were blood related. Fulfillment of the requirements for living-donor transplantation was assured by medical evaluation and positive approval by the living-donor commission of the appropriate local medical committee. Potential living-donors included first degree or second-degree relatives, a husband or wife or someone cohabiting with the patient or any person who was publicly known to be closely connected with the potential recipient. Further prerequisites for living donation were blood group compatibility and a negative lymphocyte cross-match between donor and recipient [13].

The living-donor kidney transplantation programme was restricted to a single surgeon, who was given a large case load and hence gained the opportunity of acquiring the greatest possible surgical skill. Donor nephrectomy was performed as an open operation in 54 patients (minimal pararectal retroperitoneal access) and laparoscopically in five patients (transperitoneal) with subsequent transplantation to the contralateral side. Immunosuppression (calcineurin inhibitor) was started 5 days before the planned transplantation date. Postoperatively, the related recipients (n = 44) received triple drug therapy based on cyclosporin A, while the non-related recipients (n = 15) received triple drug immunosuppression based on tacrolimus.

**Dual kidney transplantation**

Group IV comprises 31 patients who received dual kidney transplants, each from two ‘marginal’, i.e. qualitatively impaired kidney transplants from elderly (over 65 years) kidney donors, which were performed between April 1996 and December 2000. All these patients received kidneys that had not been accepted for transplantation in any other Eurotransplant centre, either for single or dual kidney transplantation, where the reasons for refusing the kidneys were the advanced age and the impaired kidney function of the donor. Prerequisites for the allocation of dual kidneys—assuming the consent of the recipient—were blood group compatibility, a recipient age over 60 years if possible and optimum tissue compatibility. The residual kidney function of these marginal kidney donors and their suitability for dual kidney transplantation were evaluated prospectively by means of the ‘Münster dual kidney score’ [20]. In these cases the ‘Münster dual kidney score’ formerly employed, which was based upon the assessment of kidney function in terms of the criteria—severity of glomerulosclerosis, kidney weight, donor age and creatinine level—was replaced from January 1999 onwards by a new Münster dual kidney score (Tables 3 and 4). In the new Münster dual kidney score the weight of the recipient is correlated with the weight and degree of sclerosis of the donor kidneys: the degree of sclerosis (as determined histologically) is deducted from the weight of both kidneys, leaving the functional weight, which is equivalent to the total mass of functioning nephrons. The functional weight is now multiplied by the body weight of the recipient and divided by 75 kg to give the corrected weight. If each individual kidney now has a recipient-correlated functional weight of >150 g, the kidneys are transplanted separately into two different recipients. If the functional weight of an individual kidney is <150 g, but if both together are over 150 g, both are transplanted as dual kidneys. Should both kidneys taken together fail to reach a functional weight of 150 g, the kidneys are not transplanted (Table 3).

From April 1996 to December 2000 the TCM received offers of kidneys from 51 marginal donors, which had been refused previously by all other transplant centres in the Eurotransplant region, chiefly because of impaired parenchymal quality and severe arteriosclerosis of the renal arteries. Of these donors 29 came from our own transplant centre and 22 from elsewhere (Figure 4). Mean donor age at 60.0 ± 16.3 years was significantly higher than in the other groups (Table 1, Figure 3). Of these 51 kidney pairs, i.e. 102 kidneys, 62 were transplanted as dual kidneys to 31 recipients. Having a functional weight of >150 g, 18 kidneys were transplanted as
single kidneys (some of them in group II). Because of inadequate functional weight, 22 donor kidneys were not transplanted.

Figure 5 illustrates the surgical technique of dual kidney transplantation. The right donor kidney is dissected out with a cava patch, which was left to enable the surgeon to connect the left donor kidney vein directly to the junction between the right kidney vein and the vena cava of the donor. The first step is to transplant the right kidney, the kidney vein being anastomosed to the external or common iliac vein, and the renal artery to the recipient’s common iliac artery. After reperfusion of the right kidney, the left donor kidney is implanted, the first step being an end-to-end anastomosis between the left renal vein and the right renal vein. The artery of the left kidney is anastomosed to the iliac circulation, either to the external or the internal iliac artery. The ureteric anastomosis is performed by the common-channel technique, in which both ureters are anastomosed to one another and the common ostium is sutured end-to-end to the bladder.

Among the 31 dual kidney transplants, in 27 patients both kidneys were transplanted unilaterally and in four patients bilaterally by the surgical technique described above, the ureteric anastomoses being performed by the common-channel technique [20]. To minimize nephrotoxicity, postoperative immunosuppression consisted of induction therapy with Simulect and was continued with cyclosporin A and cortisone in lower dosage than for cadaver donor single kidney transplantation.

Statistics
Waiting times were ascertained descriptively and compared by means of box plots. Survival and 3-year function rates were assessed by the Kaplan–Meier method. The log-rank test was used to compare significance. The influence of the patients’ age and waiting time on survival and 3-year function was determined by means of Cox regression.
Short-term function was checked for significance by the Kruskall–Wallis test ($\alpha = P < 0.05$).

**Results**

*Effect of living-donor and dual kidney transplantation on the total kidney transplantation rate, waiting times and waiting coefficients in the TCM*

Between January 1990 and December 2000, 1184 kidney transplants were performed at the TCM, of which 784 were carried out between January 1990 and February 1996 (old ETKAS) and 400 between March 1996 and December 2000 (new ETKAS). The total annual number of kidney transplants thus dropped to almost half (61%) after the implementation of the new ETKAS (Figure 6a).

The proportion of cadaver donor kidney transplants dropped from 99.1% of the total number of kidney transplantsations (old ETKAS) to 77.5% (new ETKAS), whereas the proportion of simultaneous kidney transplants (performed in combination with liver or pancreas transplants; 01/90–02/96, 0.5%; 03/96–12/00, 5.5%), living-donor kidney transplantation (01/90–02/96, 0.9%; 03/96–12/00, 12.8%) and dual kidney transplantation (01/90–02/96, 0%; 03/96–12/00, 8.5%) increased significantly (Figure 6a).

Living-donor kidney transplantation and dual kidney transplantation thus succeeded in raising the numbers of transplants performed between March 1996 and December 2000, after the introduction of the new ETKAS, by 21.3%. Living-donor kidney transplants at 12.8% accounted for a larger proportion of the total numbers of kidney transplants than did dual kidney transplants (8.5%) (Figure 6b).
The average waiting time for all patients over the period from January 1990 to December 2000 was 765.8 days, increasing continuously with rises in the years 1996 (introduction of the new ETKAS) and 2000 (new definition of waiting times by Eurotransplant) (Figure 6c).

Patients awaiting cadaver donor kidney transplantation had the longest mean waiting time at 817.1 days, whereas the mean waiting times for living-donor kidney transplantation at 241.4 days and for dual kidney transplantation at 563.1 days were significantly shorter, thereby helping to reduce the overall waiting time for all patients (Figure 6c).

The waiting coefficient increased annually from January 1990 to December 2000 from an average of 2.4 in the years January 1990 to February 1996 (old ETKAS) to an average of 6.9 in the period from March 1996 to December 2000 (new ETKAS). Like the waiting time, it was reduced by 22% (from 6.9 to 5.4) by the inclusion of living-donor kidney transplantation and dual kidney transplantation (Figure 6d).

**Evaluation of cadaver donor, living-donor and dual kidney transplantation**

No patient had to be excluded in groups I–IV. Donor and recipient ages did not differ significantly in groups I–III, but were significantly higher in group IV (dual kidney transplantation). In group III renal perfusion was performed exclusively with HTK solution. Cold-ischaemia time did not differ between groups I, II and IV, but was significantly shorter in group III. The number of mismatches showed a similar distribution pattern in all groups. After the introduction of the new ETKAS (group II) the numbers of second and third transplantations increased in comparison with the other groups. The number of patients...
Table 2. Functional parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Group</th>
<th>12 months</th>
<th>24 months</th>
<th>36 months</th>
</tr>
</thead>
<tbody>
<tr>
<td>Creatinine (mg/dl)</td>
<td>III</td>
<td>1.4 ± 0.2a</td>
<td>1.4 ± 0.2a</td>
<td>1.4 ± 0.2a</td>
</tr>
<tr>
<td></td>
<td>IV</td>
<td>1.6 ± 0.5</td>
<td>1.9 ± 0.6</td>
<td>2.2 ± 0.7</td>
</tr>
<tr>
<td>Graft survival (%)</td>
<td>I</td>
<td>93.0b</td>
<td>90.5b</td>
<td>81.0b,c,d</td>
</tr>
<tr>
<td></td>
<td>II</td>
<td>92.6c</td>
<td>91.0c</td>
<td>87.0c</td>
</tr>
<tr>
<td></td>
<td>III</td>
<td>98.4a</td>
<td>98.4a</td>
<td>98.4a</td>
</tr>
<tr>
<td></td>
<td>IV</td>
<td>95.0</td>
<td>90.5</td>
<td>89.0</td>
</tr>
<tr>
<td>Patient survival (%)</td>
<td>I</td>
<td>96.7</td>
<td>96.8</td>
<td>87.4b,c,d</td>
</tr>
<tr>
<td></td>
<td>II</td>
<td>97.8a</td>
<td>97.0a</td>
<td>96.2b</td>
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<tr>
<td></td>
<td>III</td>
<td>100a</td>
<td>100a</td>
<td>100.0a</td>
</tr>
<tr>
<td></td>
<td>IV</td>
<td>93.6</td>
<td>91.8</td>
<td>89.2</td>
</tr>
</tbody>
</table>

Group I = cadaver donor kidney transplantation 01/92-06/94; group II = cadaver donor kidney transplantation 04/96-06/98; group III = living-donor kidney transplantation; group IV = dual kidney transplantation.

\( ^a P < 0.05, \) III vs IV.

\( ^b P < 0.05, \) I vs III.

\( ^c P < 0.05, \) I vs II.

\( ^d P < 0.05, \) I vs IV.

\( ^e P < 0.05, \) II vs III.

\( ^f P < 0.05, \) II vs IV.
age. There was no evidence that the duration of waiting time had any significant influence on the long-term function rate.

Patient survival

At 3 years the survival rate in group III (living-donor kidney transplantation) was significantly the highest at 100%, followed by group II (cadaver donor kidney transplantation, new ETKAS) at 96%, and group IV (dual kidney transplantation) at 89%. All the patients in group I (cadaver donor kidney transplantation, old ETKAS) showed a significantly lower survival rate (87.5%) than those in group II (cadaver donor kidney transplantation, new ETKAS) or group III (living-donor kidney transplantation) (Table 2).

Cox regression revealed that in all groups the waiting time had no significant influence on survival after kidney transplantation. However, recipient age had a significant influence on survival rate: in all groups the probability of survival decreased as patient age increased.

Waiting time

Patients in group II (cadaver donor kidney transplantation, new ETKAS) had the longest mean waiting time (1045.7 days) followed by patients in group IV (dual kidney transplantation) with a mean of 935.5 days. On average, patients in group III (living-donor kidney transplantation) had the shortest waiting time (346.4 days) (Figure 7).

Discussion

Thanks to advances in transplantation technique, immunobiology and pharmacotherapy, kidney transplantation is now accepted as the best mode of treatment for patients with terminal kidney failure, because as compared with haemodialysis it offers higher survival rates, better quality of life and lower costs [7,8]. However, the annual number of kidney transplantsations is limited by the shortage of donor organs. Despite vigorous endeavors, there has been no increase in the numbers of organ donations over the last 10 years; this has resulted in continuously growing waiting lists, increases in waiting time and in morbidity among patients with terminal kidney failure [9–12].

Especially in times of organ donor shortage, this has led to demands for a fair and efficient system for allocating kidneys. Because of the changeover from the former 50% transplant centre-orientated kidney
allocation system in the Eurotransplant countries to the ‘new’ 100% patient-orientated ETKAS in March 1996, the allocation of kidneys was improved and made more transparent. This became evident primarily from the reduction in average and maximum waiting times, the almost complete levelling out of national kidney exchange rates and the assurance of optimal tissue compatibility between donor and recipient [4–6].

Despite the indisputably beneficial effect of the new ETKAS on the entire transplantation community, the 1-year balance sheet showed a temporary decline in the numbers of kidney transplantations in certain transplantation centres [4]. Interestingly, in the TCM the introduction of the new ETKAS led to a lasting decline in the numbers of cadaver donor kidney transplantations, although it had no adverse effect on the numbers of kidneys explanted in the TCM area. This development, which so far as we know has not yet been described by any other transplantation centre, is inherent in the structure of the TCM and has led to interesting structural changes at the TCM.

The TCM is remarkable in having an explantation area of substantial size in relation to the number of patients waiting for kidneys. As might be expected, the TCM used to profit from the old ETKAS (which was in force until February 1996), under which most of the explanted kidneys were allocated to recipients of the local transplantation centre. However, because of the fully patient-orientated allocation of donor kidneys after the introduction of the new ETKAS in March 1996, the allocation of donor kidneys became dependent on the length of the waiting list and was no longer governed by the size of the explantation area.

At the TCM this meant the ‘export’ of up to 40% of all explanted kidneys to other transplant centres; transplant numbers were almost halved and waiting times were doubled. Moreover, in subsequent years, because the waiting list at the TCM was almost unaltered, there was no increase in the number of cadaver donor kidney transplantations.

The increasing waiting time and associated mortality and morbidity among patients on the waiting list encouraged the TCM to find new alternatives to cadaver donor kidney transplantation. Living-donor and dual kidney transplantation, which were not subject to allocation under the new ETKAS, were initiated as strategies to compensate for the declining numbers of cadaver donor kidney transplants, and have led to considerable structural changes in the TCM kidney transplantation programme. In addition, by comparing four representative groups of this entity, selected in terms of donor origin, standardized surgical procedure, and a uniform postoperative regimen, it became possible to evaluate their respective qualitative and quantitative contributions to the kidney transplantation programme in the TCM.

By the end of the year 2000 the proportion of living-donor kidney transplantations at the TCM had been increased to 12.8%. By eliminating the average 5-year waiting time for a cadaver donor kidney transplant it also proved possible to significantly reduce waiting time at the TCM. This can also be demonstrated by the significantly shorter waiting time of group III (living-donor kidney transplantation) as compared with the cadaver donor transplantation (groups I and II) and the dual kidney transplantation group (group IV).

However, the waiting time for a living-donor kidney transplant was still almost 1 year, because some patients in group III had spent some time waiting for a cadaver donor kidney before they decided in favour of living-donor kidney transplantation. The internationally recognized and significantly better results of living-donor kidney transplantation as compared with cadaver donor kidney transplantation were also demonstrated in this study, and had beneficial effects on the entire kidney transplantation programme at the TCM [15]. Out of 59 living-donor kidney transplantations there was only one in which a severe vascular rejection led to loss of the kidney. In keeping with the international results, the incidence of complications among donors in the TCM was very small, partly no doubt because of the possibility of laparoscopic donor nephrectomy [13,16,18,19].

The dual kidney transplantation programme was initiated in the TCM in June 1996, but apart from a few sporadic endeavours, it has not yet been emulated in the Eurotransplant region [20]. Over the period from 1996 to 2000, 31 dual kidney transplantations were performed, these amounting to 8.5% of total kidney transplantations. Having a creatinine of 2.2 ± 0.7 mg/dl and a function rate of 89% after 3 years, the transplant function of the dual kidneys is comparable with the 3-year function of cadaver donor kidney grafts in this centre (87%), and is significantly better than the 3-year overall function for Germany as a whole (74%).

International comparison with other dual kidney transplantation programmes shows that the 1-year function rate of 94% achieved at the TCM is comparable with the results from Italy, Spain and the USA—despite differing indication criteria and poorer initial function [21–23].

The good results of dual kidney transplantation at the TCM, despite the seriously impaired quality of some transplants, can be attributed to the preoperative evaluation of marginal donor kidneys by the Münster dual kidney score, to the efforts to keep to a short cold-ischaemia time, to the high caseload of the surgeons and to the immunosuppression schedule, modified as necessary after the operation.

The decision to perform dual kidney or even single kidney transplantation was taken prospectively with the aid of the Münster dual kidney score. According to the hyperfiltration theory of Brenner et al., in marginal donor kidneys there is a critical mass of functionally capable nephrons, and if this drops below a certain level it will lead to further loss of nephrons in consequence of a vicious circle [24]. The aim of dual kidney transplantation was therefore to make available a sufficient number of functionally capable nephrons by transplanting two kidneys so as to ensure adequate kidney function in the long term. The number of functionally capable nephrons was assessed by the Münster dual
kidney score, using the weight of the kidney and a wedge biopsy containing at least 15 glomeruli taken from the donor kidney. During the course of this study the ‘old’ Münster dual kidney score—which assessed kidney function in terms of the severity of glomerulosclerosis, kidney weight, and donor creatinine level and age—was replaced by the ‘new’ Münster dual kidney score, which correlates the body weight of the recipient with the weight and degree of sclerosis of the transplant [20]. Both these dual kidney scores were compared retrospectively so as to assess the suitability of marginal kidneys for single or dual kidney transplantation. While they both have equally good selectivity, the new Münster dual kidney score is simpler in everyday clinical use. Using both Münster dual kidney scores, we were able to select 18 marginal donor kidneys, which were successfully transplanted as single kidneys (see group II). Twenty-two donor kidneys were not transplanted because their functional mass was too small.

Another important objective of dual kidney transplantation was to minimize cold-ischaemia time, this being necessary because of the diminished ischaemia tolerance of marginal donor kidneys. Despite the long transport times necessary for some marginal donor kidneys intended for dual kidney transplantation, the average cold-ischaemia time achieved in group IV was not significantly different from the time in the cadaver donor kidney transplantations (groups I and II). This was permitted by the introduction of the European Senior Program (ESP) in January 1999, which has made possible the internal allocation of kidneys from donors over 65 years of age without the involvement of any other intermediary centre [1,14] and has contributed to our dual kidney transplantation programme by greatly reducing cold-ischaemia times.

Comparison of the two cadaver donor kidney transplantation groups (I and II) shows that not all the objectives of the new ETKAS were met at the TCM. Despite the almost doubled waiting time, unchanged tissue compatibility and the larger numbers of patients receiving second or even third transplants, better transplant function and higher patient survival rates have been reached after the introduction of the new ETKAS (group II). This has several conceivable causes. We do not consider that the increased usage of UW solution as compared with group I is the crucial factor responsible for the better rate of effective kidney function, because during cold-ischaemia times of up to 20 h HTK solution and UW solution are regarded as equivalent for preserving the kidney [25]. Nor do we believe that the higher proportion of patients who had immunosuppression with tacrolimus (which is less nephrotoxic than cyclosporin A); studies with larger numbers of cases would be necessary to answer this question. The gains in long-term function rate are much more likely to be due to improvements in postoperative after-care, for example, the refinement of diagnostic techniques by duplex sonography and transplant histology, the improvements in immunosuppressive schedules with better control by immuno-monitoring or by new therapeutic approaches to virological problems.

In summary, the decrease in cadaver donor kidney transplants, which followed the introduction of the new ETKAS, constituted a special situation for the TCM, while the decline in the numbers of cadaver donor kidney transplants reflects the current situation in the transplantation community as a whole. Although some of the aims of the new ETKAS, for example, the shortening of waiting time, have not been achieved in the TCM, the kidney transplantation programme in the TCM has nevertheless shown significant gains in variety and quality since the introduction of the new ETKAS. The encouraging results obtained at the TCM with kidneys from living donors and above all with dual kidney transplantation as successful compensation strategies should stimulate other transplantation centres to search for alternatives to cadaver donor kidney transplantation and thereby to combat the continuing shortage of donor organs.

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