

Expanded criteria donors in deceased donor kidney transplantation – An Asian perspective

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ABSTRACT


There is an increasing gulf between demand and supply for kidneys in end-stage renal failure patients worldwide, especially Asia. Renal transplantation is often the treatment of choice for long-suffering patients who have to undergo dialysis on a regular basis. The utilization of expanded criteria donors (ECDs) to address the donor pool shortage has been proven to be a legitimate solution. Metzger first described the classification of standard criteria donor and ECD in 2002. Since then, the criterion has undergone various modifications, with the key aims of optimizing organ procurement rate while minimizing discard and rejection rates. We review the methods to improve selection, characterization of risks, and surgical techniques. Although the ECD kidneys have a higher risk of impaired donor and recipient outcome than the “standard criteria” transplants, it may be justified by the improved overall survival of these patients compared to those who remained on dialysis. It is, therefore, crucial that we perform meticulous selection, along with state of the art surgical techniques to maximize the use of this scarce resource. In this article, we review the pre-procurement and post-procurement processes implemented to preserve outcomes.

INTRODUCTION

End-stage renal failure (ESRF) is a growing phenomenon, with the number of ESRF patients in the United States doubling from 1990 to 2016.^[1] With the rising prevalence of diseases such as diabetes mellitus and hypertension, the number of patients on dialysis can only grow. Kidney transplantation is the unequivocal optimal renal replacement therapy with a reduced risk of mortality and better quality of life than chronic dialysis.^[2] As of 2017, there are 100,791 patients in the United States on the kidney transplant waiting list and 3000 patients join their rank every month. In comparison, a mere 17,107 kidney transplants were performed in 2014. The median interval between waitlist placement and kidney transplantation from a deceased donor has increased in recent years and is currently between three to 7 years in North America.

This increasing gulf between demand and supply is reflected worldwide. According to a report from 2001, the population of end-stage renal disease patients was increasing worldwide at a rate of 7% per year. Within Asia, the number of renal patients requiring dialysis is increasing at a much higher rate compared to that of their Western counterparts. In India, the Philippines, and China, the annual rise in ESRF patients ranges from 10% to 30%,^[3-5] and this is estimated to be further exacerbated by the increasing prevalence of diabetes and hypertension. The demographics of the renal failure patients in Asia is uniquely characterized by its earlier age of onset (40–50 years old) and the higher proportion of patients with an unknown etiology of chronic kidney disease. These two factors are likely to further compound the complexity of managing this disease and contribute to its rising socioeconomic burden.

In Singapore, the median wait time for a deceased donor kidney transplantation was 7.2 years in 2018. The critical

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shortage of kidneys available for transplantation has intensified efforts to expand the organ pool for both deceased and living kidney donor transplantation. This review aims to report on contemporary efforts in this arena with a focus on efforts applicable in Asia to maximize the use of expanded criteria donors (ECDs).

EXPANDED CRITERIA DONORS IN DECEASED DONOR KIDNEY TRANSPLANTATION

Metzger *et al.* first described the classification of standard criteria donor (SCD) and ECD in 2002.^[6] Since then, the criterion has undergone various modifications, with the key aims of optimizing organ procurement rate while minimizing discard and rejection rates. Today, the Scientific Registry of Transplant Recipients define ECD kidneys as: (1) kidneys from deceased donors aged 60 years or above, or from, (2) donors aged 50–59 years with at least two of the following: (3), cerebrovascular accident as cause of death, terminal or (4) serum creatinine >1.5 mg/dL or a history of hypertension. While ECD kidneys, as a group, have inferior outcomes compared to the kidneys from donors that do not meet the ECD definition, with a reported 70% higher risk of graft failure, many of these kidneys are potentially utilizable organs with acceptable outcomes for carefully selected patients. This is especially so for older candidates in transplanting centers with long waiting times of 4 or more years.^[7,8] Despite the potential compatibility, many transplant centers in the United States are still less willing to use these kidneys and report low ECD transplant rates.^[9] To increase ECD utilization, a number of preprocurement and postprocurement processes have been implemented to preserve outcomes.

DECEASED DONORS: IMPROVING THE CHARACTERIZATION OF RISK

The designation of SCDs or ECD is binary, but in reality, there is a continuum of quality in the donated kidneys. Pre-procurement risk stratification of ECD donors can help improve efficiency and reduce costs. In the United States, the United Network for Organ Sharing Kidney Transplantation Committee announced a new allocation criterion in 2013, based on the Kidney Donor Risk Index (KDRI), which was then revamped and finalized to the Kidney Donor Profile Index (KDPI).^[10] KDPI compiled ten donor factors that are independently associated with all-cause allograft survival to fine-tune the dichotomic SCD/ECD criteria. Lower KDPI is associated with longer predicted survival, while higher KDPI (more than 80) is associated with shorter predicted survival for the aggregate population. Unfortunately, the average c statistic for the overall cohort is 0.62 and the R square of the KDPI model is relatively low. The transition was proposed to increase the utilization of ECD kidneys for elderly patients or patients with a predicted shorter

effective posttransplant survival. However, as noted by Gupta *et al.*, while the original intent of the scoring system was to better characterize potential donor organs and not to act as a decision tool,^[11] it may actually result in an increased discard rate if there are a paucity of matching patients. In real-life scenarios, there are more confounders than the ones accounted for in the calculation of the continuous variable-KDPI; this complicates its clinical applicability to allocate kidneys and one must be cautious in utilizing KDPI alone to discriminate kidneys suitable for transplantation. In addition, as data are derived from database in the United States, the KDPI should be validated in centers outside, including Asia, to evaluate its validity before widespread application.

Kidney biopsy

A commonly utilized post procurement practice in the evaluation of ECD kidneys is the preimplantation (or explant) kidney biopsy. The role of preimplantation histopathology is still under great debate. Unresolved issues include the biopsy technique (needle vs. wedge), evaluation of the pathology (interobserver variability between renal vs. general pathologist) and the use of relevant histological parameters for graft function and survival (glomerulosclerosis, interstitial fibrosis, arteriosclerosis, and hyaline arteriosclerosis). For example, Sung *et al.* found that the performance of a biopsy and the degree of glomerulosclerosis on biopsy (>20%) were significantly associated with risks of discard, yet glomerulosclerosis was not consistently associated with graft failure.^[12] Nevertheless, in the United States, it remains an important practice with three-fourths (74.8%) of ECD kidneys biopsied compared with 18.7% of non-ECD kidneys.^[12]

More importantly, preimplantation kidney biopsies complement other strategies to make more organs available for transplantation. To mitigate the suboptimal function of one kidney, the concept of dual kidney implants was introduced. Modi *et al.*^[13] described the early experience of an Indian center with dual kidney transplantation (DKT), showing good results with kidneys from ECD. Simultaneous transplantation of two ECD kidneys with up to 40% total glomerulosclerosis can theoretically provide a larger nephron mass than the transplantation of a single kidney with 15% or more glomerulosclerosis.^[9] Remuzzi *et al.* utilized histology-based selection criteria to judge the quality of ECD kidneys and guide their allocation for a single versus dual implant.^[14] In his prospective study, kidney biopsies from donor's kidneys were obtained, and histologically scored based on the severity of chronic changes. Changes in four different kidney tissue components of vessels, glomeruli, tubules, and connective tissue were each scored from 0–3. Kidneys with global scores of 0–3 were implanted singly, and those with scores of 4–6 were considered for dual implants; those with a score of seven or greater were discarded. However, it should be noted that the practice of

DKT has not been adopted as a mainstream policy due to the sub-optimal association between pretransplant biopsy results and long-term allograft outcomes. A more accepted transplant model is the KDPI-Estimated Post-Transplant Survival (EPTS) Survival Benefit Estimator^[15] to assess survival benefit for the patient based on the candidate's EPTS and the offered kidney's KDPI.

The absence of big data in the transplant databases in Asia has meant that localized KDPI for Asian ECDs is not available, and this has increased the need to validate the KDPI in local settings. To address the question of whether a comprehensive clinical assessment can supersede the need for histological evaluation, Vathsala compared the utility of KDPI with the Remuzzi score for explant biopsy and found that the Remuzzi scoring proved superior in prognosticating short-term graft outcomes. In this Asian transplant center, KDPI alone was found to be inadequate for deciding if ECD kidneys should be single or dual implants and that explants with a Remuzzi score of more than 4 demonstrated good sensitivity, specificity, and positive predictive values for the selection of dual implant ECDs, enabling a significant number of remnant kidneys to be single implants.^[16] They concluded that explant biopsies should be routinely carried out for patients with KDRI > 1.1 for better risk stratification and kidney distribution.^[17]

In India, Kute *et al.*^[18] also described the allocation of kidneys based on pretransplant biopsy from ECD donors. There was no upper age limit set for the exclusion of kidneys. Instead, they chose to adopt an old-for-old allocation system to good effect, patient and graft survival rates of 81.7% and 92.6% with a 4-year follow-up period.

HYPOTHERMIC MACHINE PERFUSION

Another post procurement practice to improve ECD outcomes is the use of hypothermic machine perfusion. This is predominantly used in elderly Donation after Circulatory Death (DCD) kidneys. Conventionally, kidneys were maintained in static cold storage before implantation. Hypothermic machine perfusion endeavors to reduce cell metabolism by dropping the temperature while maintaining tubular, glomerular, and endothelial function with the pulsatile flow. It is postulated that this results in reduced intra-renal resistance. Level one evidence from a landmark randomized controlled study in 2009 confirmed that hypothermic machine perfusion was associated with a reduced risk of delayed graft function and improved graft survival up to 3 years after deceased donor transplantation.^[19,20] Following this, other studies have confirmed better-delayed graft function rates and nonfunction rates specifically for machine pumped ECD kidneys compared with cold storage alone.^[21] Savoye *et al.* arrived at a similar conclusion after performing a retrospective review on 4316 kidneys from ECDs in the

French Transplant registry.^[22] The meta-analysis performed by Hameed was, however, less optimistic, alluding to the promising short-term results in these studies, but noting that it have yet to be proven consistent in the long run.^[23]

The main Asian institutions that report machine hypothermic perfusion outcomes originate from established centers in Japan and China. Matsuno *et al.*^[24] and Chen *et al.*^[25] found that hypothermic perfusion optimized organ viability and machine perfusion preservation variables were useful indicators of immediate graft function. Despite its purported benefits, adoption rates of hypothermic perfusion remain low outside that of Europe and the United States.

The foremost reason is the cost of purchasing these perfusion machines, which would be incurred by the institution and the patient. Gomez *et al.* performed a cost-effectiveness analysis comparing hypothermic machine perfusion with static cold storage.^[26] They found that the upfront budgetary cost of utilizing machine perfusion was an additional €610 per patient. This study was performed in the setting of the developed Spanish National Healthcare system with notable technological capacity and human access equity. In areas with limited resources and extensive land area, the upfront cost would be further compounded. Furthermore, the need for additional resources such as perfusionists or maintenance makes the implementation of hypothermic machine perfusion challenging. That said, Gomez *et al.* and Groen *et al.*^[27] were in agreement about the overall cost savings for machine perfusion due to the reduction of delayed graft function and graft failure and the corresponding gain in quality-adjusted life years. Balancing the high initial startup costs with the superior clinical and economical outcomes of machine perfusion, it makes sense to push for machine perfusion; however, the impetus may have to come from an organizational or national level for Asian countries.

NORMOTHERMIC MACHINE PERFUSION

Another option for the organ preservation perfusion is that of normothermic machine perfusion. This method adopts the passage of warmed, oxygenated, red cell-based solution through the kidney, to allow for *ex vivo* preservation and characterization of the kidney. Hosgood *et al.*^[28] studied the use of normothermic machine perfusion for declined DCD kidneys and found that this technology could increase the potential organ pool by reducing cold storage time.

DECEASED DONORS: SURGICAL TECHNIQUES TO OPTIMISE EXPANDED CRITERIA DONORS

Following the publication on kidney allocation based on Remuzzi's scoring, DKT is increasingly utilized with success to compensate for the risk of poor long-term graft survival outcomes associated with age-related low nephron

mass.^[29] In Asia, there have been reports of increased utilization of DKTs.^[13,30] In Singapore, DKT for kidneys with Remuzzi scores of 4–7 accounts for 17%–18% of all kidney transplantations annually from 2014 to 2018 with a resultant reduced discard rate.^[31]

In adult recipients, DKT can be performed either unilaterally (both donor kidneys placed in the same iliac fossa) [Figure 1] or bilaterally [Figure 2]. Unilateral placement of both kidneys offers the advantages of single surgical access and shorter operating time. It also allows the contralateral iliac fossa to be available for future re-transplantation surgeries. Our unilateral extraperitoneal implantation technique is similar to that reported by Ekser *et al.*^[32,33] Through an extended retroperitoneal Gibson incision on the right side, the right donor kidney is preferably placed superiorly as its length can be extended by a segment of reconstructed donor inferior vena cava (IVC) [Figure 1]. Reconstruction involves mechanical stapling (Open TA30 Stapler, Medtronic, United States) of the upper and lower openings of the IVC with vascular stapler loads. This is anastomosed end to side to the right common iliac vein or in patients with shorter stature, to the recipient IVC. Alternatively, prolene sutures can also be utilized. In addition, the right kidney is placed superiolaterally because of its greater length of artery, which allows for a tension-free anastomosis with the common or proximal external iliac artery. The main difference with the Ekser technique is their preference for vascular anastomosis to the proximal external iliac vessels. We feel this may not provide adequate space for both kidneys, especially if the patient is of short stature.

After revascularization of the right kidney, vascular clamps are placed distal to its anastomosis on the iliac vessels. The left donor kidney is transplanted inferomedially with the right kidney perfused to the external iliac vessels more distally in the usual manner. Both ureters can be anastomosed separately to the bladder over DJ stents in

a Lich Gregoir manner. An alternative method would be to do an end-to-end anastomosis of the right donor kidney ureter to the native kidney ureter [Figure 1]. This is to shorten the ureter of the more cranially transplanted kidney to reduce the risk of ischemic ureteric complications from an excessively long ureter. Standardization of this technique for kidneys allocated to DKT with explant biopsies has achieved good results, with 3 year patient and graft survival of 95.6% and 90.9%, respectively.^[33] Compared to Single Kidney Transplants (SKT), DKT carries a potentially higher risk of surgical complications in elderly recipients because of the longer operating time and increased risk of anastomotic complications. Blood transfusion rates are significantly higher than SKT, but there were no other reported major complications in large series. Standardization of the DKT technique has also facilitated the performance of synchronous nephrectomy to create space for unilateral DKT in adult polycystic kidney patients.^[32]

Bilateral implantations may still be needed, especially in smaller recipient patients, to avoid excessive compression of the dual transplanted kidneys in the tight space. This is particularly applicable in Asia, where patients may be of shorter stature. Indeed, a recent systematic review on DKT techniques, covering 15 reports of 434 DKT recipients, found equivalent delayed graft function, patient and graft survival rates for bilateral and unilateral placement techniques.^[34] This means that ultimately, surgeons should choose the technique appropriate for their own skills and individualized to their patients.

DECEASED DONORS: IMMUNOSUPPRESSION IN EXPANDED CRITERIA DONOR RECIPIENTS

Another characteristic of the ECD allograft is its reported higher immunogenicity with a greater theoretical risk of increased graft loss due to the ensuing interstitial rejection.^[35] Furthermore, the nephrotoxic potential of

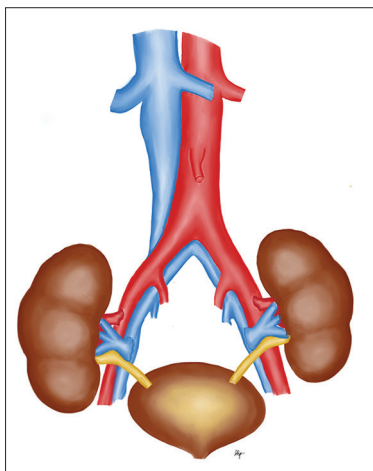


Figure 1: Ipsilateral dual kidney transplantation and the involved vascular and ureteric anastomoses

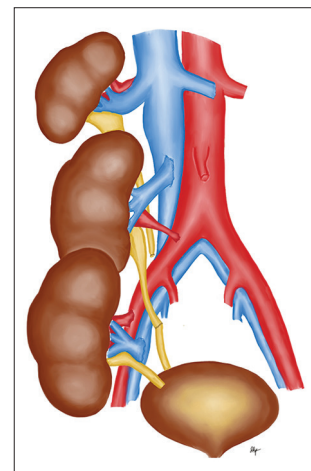


Figure 2: Bilateral dual kidney transplantation and the relevant vascular anastomoses to both iliac vessels and ureteric anastomoses to the bladder

various immunosuppressants, coupled with the elevated risks of infections or malignancies, make the adaptation of the immunosuppressant a difficult task. Despite the wealth of research into more potent immunosuppressive agents, there is some evidence that immunosuppression for ECD kidneys should trend toward moderation with no evidence that the use of more potent drugs such as thymoglobulin induction and sirolimus-based protocols offer any advantage to the traditional cyclosporin, mycophenolate mofetil, and prednisolone.^[36] Increased risks of acute rejection in recipients of ECD allograft have also not been borne out by retrospective studies^[37] Nevertheless, the Belatacept Evaluation of Nephroprotection and Efficacy as First-Line Immunosuppression Trial-Extended Criteria Donors (BENEFIT-EXT) was the first randomized controlled trial of its kind to study immunosuppression in ECD kidney recipients.^[38] It compared patients who received belatacept-based immunosuppressants of varying intensity versus those who received cyclosporine-based immunosuppression. It concluded that belatacept had comparable graft loss and death rates as cyclosporine while managing to achieve a better 7-year renal function compared to the potentially nephrotoxic calcineurin inhibitor. This work emphasized the need for more research in this area to optimize the immunological outcomes of ECD kidney transplantation.

CONCLUSION

Renal transplantation is often the treatment of choice for patients who have to undergo dialysis regularly. The utilization of ECDs and ECLDs to address the donor pool shortage has been proven to be a legitimate solution. Although these kidneys have a higher risk of impaired donor and recipient outcome than the “standard criteria” transplants, it may be justified by the improved overall survival of these patients compared to those who remained on dialysis. It is, therefore, crucial that we perform meticulous selection, proper donor optimization, along with state-of-the-art surgical techniques to maximize the use of this scarce resource.

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