

RESEARCH ARTICLE

Recipient Selection and Outcome Comparison Between Single and Dual Kidney Transplantation

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Received: 07 October 2026 Accepted: 23 October 2026 Published: 30 October 2026

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Abstract

Background: The persistent shortage of donor kidneys has stimulated broader utilization of kidneys from expanded criteria donors (ECDs), older donors, and marginal grafts. Dual kidney transplantation (DKT) was developed to maximize the use of organs that might otherwise be discarded, particularly when nephron mass from a single donor kidney is considered insufficient to ensure adequate post-transplant renal function. However, the optimal criteria for recipient selection and the comparative outcomes of single kidney transplantation (SKT) and DKT remain subjects of ongoing debate.

Methods: This narrative review summarizes current evidence regarding recipient selection strategies, donor assessment methods, surgical considerations, graft function, patient survival, and long-term outcomes associated with SKT and DKT. Particular emphasis is placed on studies published during the last two decades evaluating outcomes from marginal and expanded criteria donors.

Results: DKT has emerged as a valuable strategy for utilizing kidneys from elderly and marginal donors. Evidence indicates that carefully selected recipients undergoing DKT achieve graft and patient survival rates comparable to those observed with SKT from standard criteria donors. DKT recipients generally demonstrate lower rates of delayed graft failure than would be expected from transplantation of a single marginal kidney, while exhibiting superior long-term renal function owing to greater nephron mass. Histological evaluation, donor age, estimated glomerular filtration rate (eGFR), Kidney Donor Profile Index (KDPI), and Remuzzi scoring systems are the principal tools guiding allocation decisions. Nonetheless, DKT is associated with increased operative complexity and longer surgical times.

Conclusions: DKT represents an effective organ-preservation strategy that safely expands the donor pool and reduces organ discard rates. Appropriate donor-recipient matching remains essential to optimize outcomes. Future allocation systems integrating histological, functional, and machine-learning predictive models may further refine the decision between SKT and DKT.

Keywords: Dual Kidney Transplantation, Single Kidney Transplantation, Expanded Criteria Donor, Marginal Donor, Kidney Transplant, Recipient Selection, Graft Survival, Delayed Graft Function, Organ Allocation, Nephron Mass.

1. Introduction

Kidney transplantation remains the treatment of choice for patients with end-stage kidney disease (ESKD), providing superior survival, quality of life, and cost-effectiveness compared with dialysis. However, the

persistent disparity between organ availability and transplant demand continues to challenge transplant systems worldwide [1,2]. To address organ shortages, transplant centers increasingly utilize kidneys from expanded criteria donors (ECDs), elderly donors,

Citation: Ennio Duranti, Diletta Duranti. Recipient Selection and Outcome Comparison Between Single and Dual Kidney Transplantation. Archives of Urology. 2026; 8(2):19-23.

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and donors with comorbid conditions. Unfortunately, many of these kidneys may possess reduced nephron mass and are frequently discarded despite being potentially transplantable [3,4].

Dual kidney transplantation (DKT), first introduced in the 1990s, was conceived to optimize the utilization of kidneys that individually may not provide sufficient renal reserve but collectively can support satisfactory graft function [5]. Since its introduction, DKT has become an established strategy in selected donor and recipient populations, although significant variability exists regarding allocation criteria and recipient selection [6].

This review examines contemporary evidence comparing SKT and DKT, highlighting recipient selection strategies and clinical outcomes relevant to modern transplant practice. Appropriate recipient selection is central to the success of DKT.

Candidates typically include:

Older transplant recipients (>60 years), Patients with lower immunological risk, Individuals who may benefit from immediate transplantation rather than prolonged dialysis, Recipients without severe obesity or significant technical surgical challenges [7,8].

Many programs prioritize DKT for elderly recipients because projected graft longevity closely matches recipient life expectancy. This approach also allows younger recipients access to higher-quality organs [9].

Several allocation algorithms incorporate donor age, kidney biopsy findings, donor serum creatinine, and estimated creatinine clearance when determining whether kidneys should be transplanted individually or as a pair [10].

The Remuzzi histological scoring system remains among the most widely used approaches. Kidneys with low biopsy scores are allocated for SKT, whereas intermediate scores often support DKT allocation; severely damaged kidneys are discarded [11].

Table 1. Patient Survival After Single and Dual Kidney Transplantation

Outcome	SKT Standard Donor	SKT Marginal Donor	DKT
1-year patient survival	95-98	92-96	93-97%
3-year patient survival	88-94%	85-91%	86-92%
5-year patient survival	80-90%	72-85%	70-85%
10-year patient survival	55-75%	45-65%	45-70%

Sources: Gill et al. [19], Kayler et al. [16], Bhayana et al. [18], Fananapazir et al. [9].

Legend: DKT recipients are generally older and therefore patient survival largely reflects recipient age rather than graft quality.

2. Donor Assessment and Allocation Strategies

The primary objective of DKT is to maximize nephron mass while avoiding transplantation of kidneys with irreversible structural damage.

Parameters commonly evaluated include:

Donor age

Estimated glomerular filtration rate

Presence of hypertension or diabetes

KDPI score : Every kidney offered for a transplant has a Kidney Donor Profile Index (KDPI) score. The score ranges from zero to 100. The KDPI estimates how long the kidney will work compared to other kidneys. A KDPI score of 20 means that the kidney will work longer than 80 percent of all other kidneys. [3,4,5]

Histological assessment

Cold ischemia time

Machine perfusion parameters [12,13]

Many centers consider DKT when donor age exceeds 70 years, particularly when histological evaluation demonstrates moderate chronic changes [14].

Recent studies have suggested that predictive models integrating KDPI and biopsy findings outperform age-based criteria alone, improving allocation efficiency and reducing unnecessary kidney discard rates [15].

3. Comparison of Clinical Outcomes

3.1 Patient Survival

Numerous registry analyses have demonstrated comparable patient survival between carefully selected DKT recipients and recipients of SKT from standard donors [16,17].

Several studies report five-year patient survival exceeding 70-80% following DKT, particularly among older recipients [18]. (Table 1)

3.2 Graft Survival

Graft survival after DKT has progressively improved over the past two decades. The United Network for Organ Sharing (UNOS) analyses have demonstrated that DKT recipients achieve acceptable long-term

graft survival despite receiving kidneys that would otherwise be discarded [19].Studies comparing DKT with SKT from marginal donors generally report superior graft survival for DKT when donor quality is particularly poor [20]. (Table 2)

Table 2. Death-Censored Graft Survival After Single and Dual Kidney Transplantation

Outcome	SKT Standard Donor	SKT Marginal Donor	DKT
1-year graft survival	92-97%	88-94%	90-95%
3-year graft survival	85-92%	75-85%	82-90%
5-year graft survival	75-88%	60-78%	75-87%
10-year graft survival	50-70%	35-55%	50-68%

Sources: Mohanka et al. [17], Alfrey et al. [20], Gill et al. [19], Ekser et al. [22].

Key message: DKT consistently demonstrates superior graft outcomes compared with transplantation of a single marginal kidney and approaches results observed with standard donor SKT.

3.3 Renal Function

One of the principal advantages of DKT is greater nephron mass.

Recipients frequently achieve:

Lower serum creatinine concentrations

Higher eGFR

Better long-term renal functional reserve compared with recipients receiving a single marginal kidney [21].

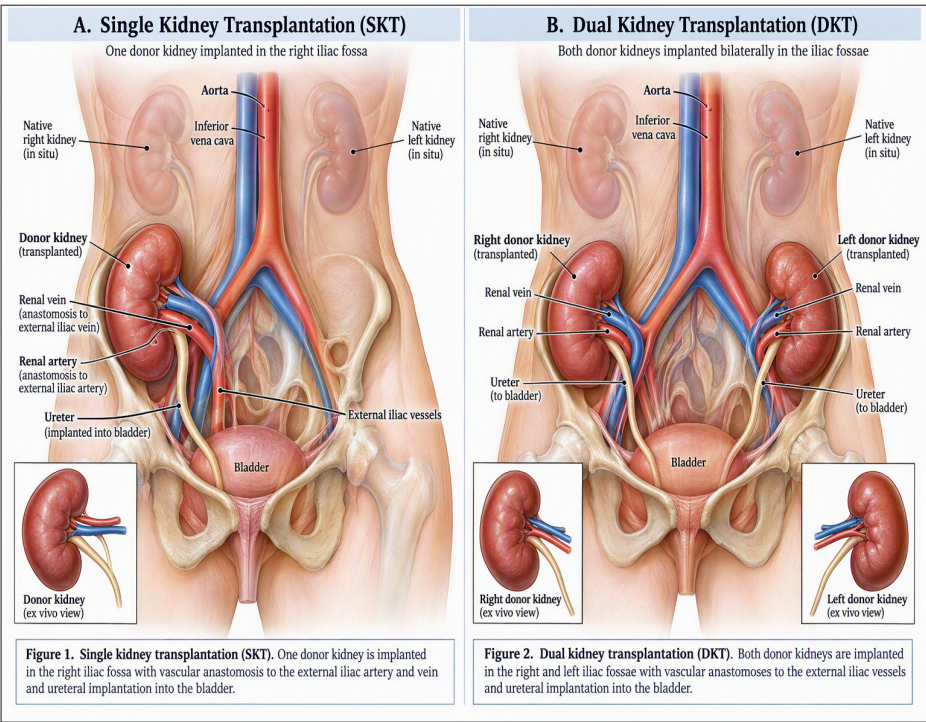
These advantages become particularly evident beyond the first post-transplant year [22].

3.4 Delayed Graft Function

Delayed graft function (DGF) remains an important determinant of long-term transplant success. Although kidneys selected for DKT originate from marginal donors, several studies have reported DGF rates comparable to or only slightly higher than those observed after SKT from standard donors [23].The increased nephron mass may partially compensate for reduced intrinsic donor kidney quality [24].

3.5 Surgical Considerations

DKT requires greater technical expertise than conventional SKT. (Fig 1 , Fig 2)



Anatomical comparison between single kidney transplantation (SKT) (Fig 1)and dual kidney transplantation (DKT) (Fig 2). Panel A illustrates implantation of a single donor kidney in the right iliac fossa. Panel B illustrates transplantation of both donor kidneys into a single recipient, providing increased functional nephron mass and superior utilization of organs from expanded criteria donors.

Potential disadvantages include:

Longer operative time

Increased vascular anastomoses

Greater risk of vascular thrombosis

Higher perioperative complexity [25].

Nevertheless, contemporary surgical techniques have substantially reduced complication rates. Several high-volume centers now report outcomes comparable to those observed following SKT [26].

3.6 Contemporary Challenges and Future Perspectives

Despite favorable outcomes, significant heterogeneity remains regarding DKT allocation protocols.

Major unresolved issues include:

Lack of universally accepted donor-selection criteria

Variability in biopsy interpretation

Differences among national allocation policies

Emerging role of machine perfusion technologies [27].

Artificial intelligence and predictive analytics may improve donor-recipient matching by integrating histological, functional, and demographic variables into individualized allocation strategies [28]. The increasing age of donor populations worldwide suggests that DKT will remain an important component of transplant programs in coming decades.

4. Discussion

The growing demand for kidney transplantation and progressive aging of donor populations have increased the relevance of DKT as a strategy to expand organ availability. Evidence accumulated over the last twenty years indicates that DKT successfully rescues kidneys at high risk of discard while maintaining acceptable graft and patient outcomes.

A fundamental concept underlying DKT is nephron dosing. Marginal kidneys often possess reduced functional nephron mass due to age-related nephrosclerosis, vascular disease, and chronic injury. Transplanting both kidneys into a single recipient compensates for these deficits and results in functional outcomes often approaching those achieved with standard donor organs [5,21]. Recipient selection remains the cornerstone of successful DKT. Older recipients represent the ideal target population because life expectancy and expected graft survival are frequently well matched. This strategy contributes

to equitable allocation while maximizing utility from expanded criteria donors [9,16].

An important controversy concerns the relative value of preimplantation biopsy. While the Remuzzi scoring system remains influential, interobserver variability among pathologists and differences in biopsy techniques limit universal applicability. Recent investigations suggest that combining histological assessment with KDPI, donor eGFR, and machine perfusion metrics may provide more accurate prediction of graft performance than biopsy alone [13,15].

Registry data consistently demonstrate that DKT offers superior outcomes compared with continued dialysis for candidates who might otherwise remain on waiting lists. Moreover, when compared with transplantation of a single marginal kidney, DKT often provides greater long-term renal function and improved graft longevity [19,20].

Future developments will likely focus on personalized allocation models integrating donor pathology, molecular biomarkers, machine perfusion characteristics, and recipient factors. Such strategies may allow more precise differentiation between kidneys suitable for SKT and those better allocated as DKT, ultimately reducing discard rates while maintaining excellent clinical outcomes.

5. Conclusion

Dual kidney transplantation has become a validated and effective strategy for expanding the deceased-donor kidney pool. When donor selection and recipient matching are appropriately performed, DKT provides patient and graft survival comparable to conventional transplantation while reducing the discard of potentially transplantable organs. The integration of histological evaluation, donor functional assessment, and advanced predictive models will likely further optimize utilization of marginal donor kidneys. DKT should therefore remain a key component of modern transplant programs seeking to address the growing disparity between organ supply and demand.

6. References

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