Procurement Biopsies in the Evaluation of Deceased Donor Kidneys


Abstract

Background and objectives Biopsies taken at deceased donor kidney procurement continue to be cited as a leading reason for discard; however, the reproducibility and prognostic capability of these biopsies are controversial.

Design, setting, participants, & measurements We compiled a retrospective, single-institution, continuous cohort of deceased donor kidney transplants performed from 2006 to 2009. Procurement biopsy information—percentage of glomerulosclerosis, interstitial fibrosis/tubular atrophy, and vascular disease—was obtained from the national transplant database. Using univariable, multivariable, and time-to-event analyses for death-censored graft survival, we compared procurement frozen section biopsy reports with reperfusion paraffin-embedded biopsies read by trained kidney pathologists (n=270). We also examined agreement for sequential procurement biopsies performed on the same kidney (n=116 kidneys).

Results For kidneys on which more than one procurement biopsy was performed (n=116), category agreement was found in only 64% of cases (κ=0.14). For all kidneys (n=270), correlation between procurement and reperfusion biopsies was poor: overall, biopsies were classified into the same category (optimal versus suboptimal) in only 64% of cases (κ=0.25). This discrepancy was most pronounced when categorizing percentage of glomerulosclerosis, which had 63%-agreement (κ=0.15). Interstitial fibrosis/tubular atrophy and vascular disease had agreement rates of 82% (κ=0.13) and 80% (κ=0.15), respectively. Ninety-eight (36%) recipients died, and 56 (21%) allografts failed by the end of follow-up. Reperfusion biopsies were more prognostic than procurement biopsies (hazard ratio for graft failure, 2.02; 95% confidence interval, 1.09 to 3.74 versus hazard ratio for graft failure, 1.30; 95% confidence interval, 0.61 to 2.76), with procurement biopsies not significantly associated with graft failure.

Conclusions We found that procurement biopsies are poorly reproducible, do not correlate well with paraffin-embedded reperfusion biopsies, and are not significantly associated with transplant outcomes.


Introduction

Discard rates for kidneys that have been procured for potential deceased donor kidney transplants in the United States are at an all-time high, and the most commonly cited reason for discard is procurement biopsy findings (1–4). The decision to accept or reject an organ for transplant is a complex process that takes into account donor and recipient characteristics, anatomic and immunologic information, and longevity matching considerations among other factors. Procurement biopsies are performed in approximately one-half of all deceased donor kidneys and 85% of expanded criteria donor/high kidney donor profile index donor kidneys in the United States (5,6). Prior analyses have raised significant questions about the ability of procurement biopsy findings alone to identify organs that should not be transplanted (1,2,4,6–9). Smaller studies have also raised concerns about the reproducibility of the findings on a procurement/donor biopsy (subsequently referred to as “procurement biopsy”) that raise additional questions about the predictive value of procurement biopsy histologic findings (9–16). Nevertheless, it is clear that clinicians rely, at least in part, on these biopsies for their assessment of transplant suitability given that biopsy findings were listed as the main reason for discard in approximately 37% of all kidneys that were procured but ultimately discarded (2–4,7,17).

We previously showed that reperfusion biopsies have prognostic value for deceased donor kidney transplant but not living donor kidney transplant recipients (18). Nevertheless, deceased donor allografts with suboptimal histology had reasonable intermediate-term outcomes, underscoring the value of these organs for at least a subset of patients (2,18). However, reperfusion biopsies performed at implantation are, by definition, unavailable before transplantation and thus, have no effect on the decision to accept/reject an organ. In contrast to procurement biopsies, reperfusion biopsies are performed under...
ideal circumstances, and they are read by experienced kidney pathologists using multiple special stains (18). Procurement biopsies are frequently wedge biopsies, and due to time constraints, they are processed as frozen sections, typically using a single stain, and read frequently by on-call pathologists who may or may not have additional training in kidney pathology (5,10,18).

Notwithstanding underlying differences in technique and interpretation, many United States transplant centers are likely to continue to request procurement biopsies, because they provide seemingly objective information about organ quality to aid decision making during time-sensitive organ offers. Thus, we performed this study to understand the predictive value and reproducibility of procurement biopsies relative to reperfusion biopsies for kidneys transplanted at Columbia University Medical Center.

Materials and Methods

Study Population

We compiled a continuous cohort of all deceased donor kidney transplants performed at Columbia University Medical Center from January 1, 2006 to December 31, 2009 (n=547) (Figure 1). Using United Network for Organ Sharing data queries and DonorNet, we recorded details from all procurement biopsy reports as noted for deceased donor kidney transplants conducted during this time period (n=292 kidneys with procurement biopsies). We restricted our analysis to donors for whom a kidney donor risk index (KDRI) could be calculated and whose biopsy reports included complete information on degree of glomerular sclerosis, interstitial fibrosis and tubular atrophy, and vascular disease (n=270). We excluded kidneys with biopsy reports that lacked complete information on these histologic parameters (n=22) (Figure 1). If a kidney underwent more than one biopsy during procurement and allocation (n=116), the results of all biopsies were recorded. In addition to these procurement biopsy reports, we recorded the kidney pathologists’ interpretations of the reperfusion biopsies performed on the same donor allografts 1 hour after reperfusion for comparison.

Data from Procurement and Reperfusion Biopsies

Both procurement and reperfusion biopsy reports were evaluated for degree of glomerulosclerosis, interstitial fibrosis and tubular atrophy, and vascular disease. For each of these histologic parameters, we assigned a rating of zero (best) to three (worst) on the basis of the pathologists’ assessment (definitions are in Table 1) (18). Kidneys were further assigned an “optimal” rating if they had either zeroes or ones for each of the histologic parameters. Kidneys that rated more than one on at least one of the three histologic parameters were assigned a “suboptimal” rating, consistent with prior data (18). We extracted additional DonorNet data from procurement biopsies when available, including biopsy location, wedge versus core, and staining/processing methodology, although these data were not consistently available. For kidneys with multiple procurement biopsies before allocation, the final biopsy result was used for comparison with the reperfusion biopsy, because the final biopsy is the one that was most closely linked temporally to the decision to accept the organ for transplantation. Kidneys that underwent more than one procurement biopsy were also used to determine the reproducibility of procurement biopsies on the same organ by comparing agreement between sequential biopsies. Of note, kidneys with multiple procurement biopsies were typically imported from other organ procurement organizations, with the initial biopsy performed and read by the procuring organ procurement organization and the final biopsy performed by a pathology service outside our institution that is contracted to do so by our organ procurement organization.

Reperfusion biopsies are performed for all kidneys at Columbia University Medical Center as the standard of care after allograft implantation. Reperfusion biopsies of the allograft were core biopsies that were obtained using an 18-gauge spring-loaded needle, and they were processed using formalin fixation, paraffin embedding, and the use of hematoxylin and eosin, periodic acid–Schiff, Masson trichrome, and Jones methenamine silver stains performed on 11 serial sections before review by experienced kidney pathologists.

Clinical Variables

For each transplant, demographic and clinical data for the recipient were obtained from the clinical record. An “imported” kidney was defined as a kidney procured outside of the local donor service area served by LiveOnNY. Transplant-specific variables, including cold ischemia time, multiorgan transplant, preemptive status of the recipient, and occurrence of delayed graft function, were also obtained. We also calculated KDRI, a validated composite measure of deceased donor organ quality, for each kidney transplant. End points of interest included graft failure and patient death.

Statistical Analyses

We performed t tests and chi-squared tests to compare demographic and clinical variables between suboptimal and optimal biopsies for both procurement and reperfusion biopsies. We used nonparametric one-way ANOVA tests to determine differences across total histologic classifications on the basis of four distinct categories of discordance between procurement and reperfusion biopsies: optimal on both biopsy types, suboptimal on procurement but optimal on reperfusion, optimal on procurement but suboptimal on reperfusion, and suboptimal on both biopsy types. The clinical characteristics of the individual groups were compared post hoc. Concordance between optimal and suboptimal ratings for each of the three histologic parameters was assessed using a 2×2 frequency table and the simple κ coefficient computed as a measure of interrater agreement. Percentage agreement was calculated simply as the percentage of patients who received either both suboptimal or both optimal determinations from the procurement and reperfusion biopsies. Unadjusted death-censored graft survival analysis was performed using the Kaplan–Meier method and log rank test. We performed univariable and multivariable time-to-event analyses for death-censored graft failure using Cox proportional hazards.
models. Patients who were lost to follow-up were censored on the last date that follow-up was available. No sensitivity analyses were performed. Analyses were performed using SAS 9.4 (SAS Institute Inc., Cary, NC) and Stata 14.2 (StataCorp, College Station, TX). All clinical and research activities associated with this study were consistent with the principles of the Declaration of Istanbul, and the study was approved by the Columbia University Medical Center Institutional Review Board.

Results

Population Characteristics

There were 547 deceased donor kidney transplants at our center over the 4-year study period (Figure 1). Of these, 292 (53%) kidneys had at least one procurement biopsy performed either at the time of procurement (at the donor organ procurement organization) or subsequently by another organ procurement organization during organ allocation. Of the biopsied kidneys, 270 (93%) had enough

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*Indicates agreement between procurement and reperfusion biopsies

**Indicates agreement between sequential procurement biopsies

Figure 1. Flow chart for procurement/reperfusion biopsy cohorts. CUMC, Columbia University Medical Center; IFTA, interstitial fibrosis/tubular atrophy; Tx, transplant. *Agreement between procurement and reperfusion biopsies. **Agreement between sequential procurement biopsies.
information to calculate the KDRI and complete documentation on the degree of glomerulosclerosis, interstitial fibrosis and tubular atrophy, and vascular disease in the procurement biopsy report. Among these, 172 (64%) kidneys were rated as having optimal procurement histology. Although the majority of kidneys underwent a single procurement biopsy, 116 of 270 (43%) were biopsied twice during the allocation process.

Kidneys with optimal histology on either the procurement or the reperfusion biopsy tended to be from younger donors with fewer comorbidities and lower KDRI compared with kidneys with suboptimal histology (Supplemental Tables 2). Recipient and transplant characteristics were similar between suboptimal and optimal kidney classification by procurement and reperfusion biopsy. Of note, among the 154 procurement biopsy reports that noted the technique (wedge versus core), suboptimal histology was significantly more commonly reported among wedge biopsies than core biopsies (59% versus 31%; P=0.002). Procurement biopsies had more glomeruli per biopsy than reperfusion biopsies. At the most recent follow-up, kidneys with suboptimal reperfusion categorization were less likely to be functioning (31% versus 53%; P<0.01).

Procurement Biopsy Repeatability

Of the kidneys that underwent more than one procurement biopsy (n=116), there was overall category agreement between sequential biopsies in terms of optimal versus suboptimal histology in 64% of cases. Agreement for the individual histology components between sequential procurement biopsies was comparable at 79%, 85%, and 84% for percentage glomerulosclerosis, interstitial fibrosis, and tubular atrophy, and vascular disease, respectively, with κ scores ranging from 0.15 to 0.23 (Table 2).

**Concordance between Procurement Biopsies and Reperfusion Biopsies**

Results for discordance in histologic categorization between procurement and reperfusion biopsies were as follows: optimal on both biopsy types in 111 (41%), suboptimal on procurement but optimal on reperfusion in 37 (13%), optimal on procurement but suboptimal on reperfusion in 61 (23%), and suboptimal on both biopsy types in 61 (23%) (Table 3). Kidneys with suboptimal procurement biopsies (suboptimal on procurement but optimal on reperfusion as well as suboptimal on both biopsy types) tended to come from donors that were older and had significantly higher KDRI values compared with the reference group of kidneys categorized as optimal on both biopsy types (P<0.01 for both comparisons). Kidneys that were classified as suboptimal on reperfusion were more likely to have come from expanded criteria donors and donors with hypertension compared with the reference group (P<0.01 for both comparisons). Additionally, kidneys classified as optimal on procurement but suboptimal on reperfusion were more similar to kidneys that were suboptimal on both biopsy types compared with kidneys classified as suboptimal on procurement but optimal on reperfusion biopsy (Table 3). Notably, recipient characteristics were not significantly different between the biopsy discordance categorization groups.

As shown in Table 4, overall agreement in terms of optimal versus suboptimal categorizations between procurement and reperfusion biopsies was noted in 64% of

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**Table 1. Histologic classification and scoring**

<table>
<thead>
<tr>
<th>Score</th>
<th>Glomerulosclerosis, %</th>
<th>Interstitial Fibrosis and Tubular Atrophy, %</th>
<th>Vascular Disease</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>&lt;5</td>
<td>&lt;5</td>
<td>None</td>
</tr>
<tr>
<td>1</td>
<td>5–10</td>
<td>5–10</td>
<td>Mild</td>
</tr>
<tr>
<td>2</td>
<td>11–25</td>
<td>11–25</td>
<td>Moderate</td>
</tr>
<tr>
<td>3</td>
<td>&gt;25</td>
<td>&gt;25</td>
<td>Severe</td>
</tr>
</tbody>
</table>

“Optimal” histology was defined by a score of zero or one for each of the three histologic parameters. In contrast, a score of two or three was given to any parameter designated as “suboptimal.”

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**Table 2. Concordance of histologic findings for 116 transplanted kidneys with repeat procurement biopsies**

<table>
<thead>
<tr>
<th>Histology</th>
<th>Percentage of Glomerulosclerosis (%)</th>
<th>Percentage of Interstitial Fibrosis and Tubular Atrophy (%)</th>
<th>Vascular Disease Present (%)</th>
<th>Histologic Classification (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Both optimal</td>
<td>86 (74)</td>
<td>94 (81)</td>
<td>94 (81)</td>
<td>60 (52)</td>
</tr>
<tr>
<td>First optimal, second suboptimal</td>
<td>7 (6)</td>
<td>12 (10)</td>
<td>9 (8)</td>
<td>19 (16)</td>
</tr>
<tr>
<td>First suboptimal, second optimal</td>
<td>17 (15)</td>
<td>6 (5)</td>
<td>10 (9)</td>
<td>23 (20)</td>
</tr>
<tr>
<td>Both suboptimal</td>
<td>6 (5)</td>
<td>4 (4)</td>
<td>3 (3)</td>
<td>14 (12)</td>
</tr>
<tr>
<td>Percentage agreement</td>
<td>92 (79)</td>
<td>98 (85)</td>
<td>97 (84)</td>
<td>74 (64)</td>
</tr>
<tr>
<td>κ</td>
<td>0.22</td>
<td>0.23</td>
<td>0.15</td>
<td>0.14</td>
</tr>
</tbody>
</table>
cases ($\kappa=0.25$). Agreement for the individual components of the histologic score was also comparable between biopsy types. There was only 63% agreement for percentage of glomerulosclerosis categorization ($\kappa=0.15$), whereas agreement for interstitial fibrosis and tubular atrophy was 82% ($\kappa=0.13$) and for vascular disease was 80% ($\kappa=0.15$).

**Clinical Outcomes**

Ninety-eight (36%) recipients died, and 56 (21%) allografts failed by the end of follow-up. On univariable analysis, suboptimal histology on reperfusion biopsies but not procurement biopsies was significantly associated with inferior allograft outcomes (Figure 2, Table 5). Allografts identified as suboptimal on the procurement biopsy alone did not display worse outcomes compared with those with optimal histology, whereas allografts with suboptimal histology on the reperfusion biopsy were associated with worse outcomes regardless of whether the procurement biopsy histology was classified as optimal or suboptimal. These histologic associations with allograft outcomes persisted on multivariable analysis controlling for KDRI, recipient age, and dialysis vintage (Table 5). Although suboptimal reperfusion biopsies had significantly worse outcomes compared with allografts that had optimal histology on both procurement and reperfusion biopsies, they did not seem to be significantly worse than allografts that were suboptimal only on the procurement biopsies.

**Discussion**

Despite a shortage of kidneys available for transplantation, about one of every five kidneys procured from deceased donors is discarded, with procurement biopsy findings cited as the most frequent reason for discard (1–4,7,17). Kidney biopsies are generally considered by clinicians to be objective, reliable, and reproducible measures of organ quality, despite evidence questioning this dogma (10,16). Seemingly objective measures, such as percentage of glomerulosclerosis, have been considered reliable indicators of organ quality, especially given early literature showing an association between increased glomerulosclerosis...
and poor outcomes (12–15). However, the poor reproducibility of this measure on small biopsy samples with few glomeruli is often overlooked (16,19). Similarly, the subjective nature of other procurement biopsy findings is often discounted as are differences between wedge and needle core biopsies. This results in a potential overweighting of the significance/prognostic value of biopsy findings when assessing organ offers (2,3,5,7,10,15,19,20). We analyzed 270 kidneys that underwent procurement biopsies and found that, in our cohort, wedge biopsies were almost twice as common in the kidneys that were deemed suboptimal. This finding is consistent with prior reports, and it underscores the concern that the tissue in wedge biopsies contains disproportionately subcapsular parenchyma and therefore, likely results in over-representation of the degree of glomerulosclerosis and interstitial fibrosis and tubular atrophy compared with needle core biopsies. This sampling issue is likely a contributor to the increased rate of discards attributed to biopsy findings, especially in instances of unilateral discards (18). However, research is needed on the effect of biopsy technique on risk of postimplantation bleeding, because a theoretical increase in the risk of bleeding with core needle biopsies (due to potentially higher risk of larger vessels) plays a large role in some centers’ preference for wedge biopsies (21).

Our study is the first reported attempt to ascertain the concordance between procurement and reperfusion biopsy findings and correlate these with outcomes in a large cohort of deceased donor kidney transplants with long-term follow-up. As a center that frequently uses organs declined by multiple other centers, our cohort has a high prevalence (36%) of kidneys with suboptimal histologic features. Center-level practices of accepting kidneys from donors with AKI who have been turned down by other centers also likely explain the higher terminal creatinine reported in the group with both optimal biopsies. In addition, our extended follow-up of this cohort allowed us to assess important intermediate-term outcomes.

Our analysis underscores the prognostic value of the reperfusion biopsy findings, even in a multivariable model as we have previously reported (18). However, in stark contrast, kidney histology on procurement biopsy reports did not identify allografts at risk of early failure (HR, 1.30; 95% CI, 0.84 to 2.02 P=0.50). This calls into question the value of procurement biopsy for adjudicating kidney quality for transplantation. Our findings further undercut the value of procurement biopsies given significant discrepancies for glomerulosclerosis, interstitial fibrosis and tubular atrophy, and vascular disease between sequential procurement biopsies in kidneys that underwent more than one biopsy during allocation. We found that κ scores for these biopsy components ranged from just 0.15 to 0.23. These inconsistencies highlight a fundamental reproducibility problem when using procurement biopsies as part of the decision to accept or reject an organ (22). These findings are also consistent with a prior report by Kasiske et al. (5) of poor correlation between findings on sequential procurement biopsies on the same kidney, despite the fact that glomerulosclerosis ($r^2=0.25$) was strongly associated with kidney discard. Muruve et al. (19) similarly found that multiple biopsies performed on discarded kidneys showed significantly variability in glomerulosclerosis.

For a biopsy to be clinically useful, it must be both reproducible and associated with outcomes. Our analysis calls into question the value of procurement biopsies as currently performed and analyzed with respect to both of these tenets. There are several reasons that may account for procurement biopsies’ lack of utility. (1) They are performed under suboptimal conditions—typically, wedge biopsies that use a single stain on frozen tissue sections. (2) They are read, often in the middle of the night, by an on-call pathologist who may or may not have specific kidney pathology training. (3) There is currently no standardization of the reporting, and (4) clinicians evaluating the pathology findings may be unaware of the type of biopsy and the expertise of the pathologist reading the biopsy. Compared with core needle biopsies, the wedge biopsies typically performed at procurement often provide an over-representation of glomerulosclerosis and vascular disease, because more subcapsular glomeruli and smaller arteries/arterioles are sampled using the wedge biopsy technique (5,15,19,23,24). With regard to typical frozen sections, subtle findings, such as interstitial fibrosis and tubular atrophy, glomerular capillary wall thickening, mesangial cellularity, and insults related to diabetes and other comorbidities (each of which could potentially affect graft survival), are often more difficult to discern compared with properly fixed and stained sections (6,25). Although paraffin-embedded biopsies are considered the superior method for assessing kidney tissues, they require much more time to prepare and are not feasible for rapid organ quality assessment during transplant allocation. A prior analysis by Azancot et al. (10) showed that results of procurement biopsies as read by pathologists with specific

### Table 4. Concordance of histologic findings for 270 transplanted kidneys with both procurement and reperfusion biopsies

<table>
<thead>
<tr>
<th>Histology</th>
<th>Percentage of Glomerulosclerosis</th>
<th>Percentage of Interstitial Fibrosis and Tubular Atrophy</th>
<th>Vascular Disease Present</th>
<th>Histologic Classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Both optimal</td>
<td>143 (53%)</td>
<td>212 (79%)</td>
<td>208 (78%)</td>
<td>111 (41%)</td>
</tr>
<tr>
<td>Procurement optimal, reperfusion suboptimal</td>
<td>81 (30%)</td>
<td>20 (7%)</td>
<td>26 (10%)</td>
<td>61 (23%)</td>
</tr>
<tr>
<td>Procurement suboptimal, reperfusion optimal</td>
<td>19 (7%)</td>
<td>28 (10%)</td>
<td>25 (7%)</td>
<td>31 (14%)</td>
</tr>
<tr>
<td>Both suboptimal</td>
<td>27 (10%)</td>
<td>10 (3%)</td>
<td>9 (2%)</td>
<td>61 (23%)</td>
</tr>
<tr>
<td>Percentage agreement</td>
<td>0.15</td>
<td>0.13</td>
<td>0.15</td>
<td>0.23</td>
</tr>
</tbody>
</table>

Figure 2. Unadjusted Kaplan–Meier curves for the final Cox model exposure and outcome. In contrast to reperfusion biopsy histology, procurement biopsy histology is not significantly associated with allograft failure.
training in kidney pathology were significantly associated with post-transplant outcomes in contrast to the biopsies as read by on-call pathologists. This effect of pathologist training likely helps further explain why reperfusion biopsies (which were all read by kidney pathologists) were associated with post-transplant outcomes, whereas procurement biopsies (read by on-call pathologists) were not. It should be noted, however, that, although outcomes of kidneys with suboptimal histology on reperfusion biopsies are inferior to those with optimal histology, the use of these kidneys is still associated with acceptable 5-year outcomes and provides quality of life and better survival when allocated to appropriate recipients (18).

Our study has several limitations. In this single-center, retrospective study, we cannot eliminate the possibility of residual confounding. Our ability to draw definitive conclusions about the role of procurement biopsies may be limited by potential selection bias in that we were unable to include biopsy findings for kidneys that were not transplanted. It is possible that, although kidneys with suboptimal histology on procurement biopsy do not perform worse than those with optimal histology, kidneys with extensive, irreversible histologic abnormalities on procurement biopsies may perform worse, were, therefore, immediately discarded, and thus, excluded from our analyses. In addition, because procurement biopsy findings are primarily used to inform the decision about whether a given organ should be transplanted at all, we are unable to directly comment on the possible appropriate decline and subsequent discard of kidneys that were not transplanted and thus, were not in our cohort. Although the absence of these kidneys may potentially introduce an inclusion bias in our analysis, we should also point out that this has not been supported by analyses that have looked at the discard of unilateral kidneys given concerns about biopsy findings (26). In those circumstances, previous analyses of outcomes for the contralateral kidney that was transplanted have suggested that the choice to discard was often incorrect. There is also a lack of standardization in biopsy reporting policies among organ procurement organizations. As a result, the type (wedge versus core), staining protocol, and pathologist (i.e., amount of specialized kidney pathology training/experience) were not recorded or available for a majority of procurement biopsy reports. The absence of these data precluded our ability to perform further subanalyses that would be useful to determine the most appropriate ways to standardized biopsy review, including a comparison of biopsy readings by pathologists with and without kidney pathology training.

With regard to study strengths, our analysis is the largest of its kind comparing the reported histology between procurement and reperfusion biopsies for transplanted allografts. Our extended follow-up allowed us to report on intermediate- to long-term outcomes. Although the data were analyzed retrospectively, the decisions to perform biopsies and the assessments of those biopsy by experienced kidney pathologists were performed prospectively without foreknowledge of outcomes. In addition, the pathologists read the reperfusion biopsies without reviewing the procurement biopsy or otherwise knowing the reported findings, eliminating the potential for assessor detection bias.

Procurement biopsies continue to play a significant role in the evaluation of procured deceased donor kidneys in the United States. Our analysis found that procurement biopsies are poorly reproducible, do not correlate well with reperfusion biopsy findings, and are not associated with death-censored graft survival. Given that unfavorable procurement biopsy findings account for approximately 38% of kidney discards (27), these findings suggest that many of these discards may be inappropriate and thus call into question the utility of procurement biopsies—as
Currently performed and interpreted—in the absence of greater standardization of the process across organ procurement organizations. Efforts to improve the predictive value of these biopsies should be undertaken, including requiring biopsy review by experienced kidney pathologists (perhaps even remotely using digital modalities) and standardization of biopsy technique. Our findings also suggest an urgent need to re-examine the role of procurement biopsies during allocation given their high resource requirements and association with discards. We believe that prospective and randomized studies are needed to definitively understand the ideal role of procurement biopsies in ensuring efficient and appropriate organ allocation and utilization. While waiting for these more definitive studies, avoiding the use of wedge biopsies and improvements in the standardization of evaluation of procurement biopsies and subsequent reporting are important next steps (28). We can ill afford to continue to discard deceased donor kidneys on the basis of poorly validated criteria.

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Disclosures

None.

References


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