



Trends in utilization and perioperative outcomes in live donor nephrectomies: a multi-surgical discipline analysis

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Abstract

Objective We aim to analyze the trends in donor nephrectomy (DN) across three surgical disciplines—urology, general surgery, and transplant surgery, specifically to analyze the surgical techniques and perioperative outcomes.

Materials and methods We reviewed all live DN reported in the Statewide Planning and Research Cooperative System database of New York State (NYS) from 1995 to 2015. Surgeons were grouped in their respective disciplines using their state license number and the American Medical Association masterfile. We analyzed the volume of DN performed by each group along with how the surgical approach is, such as open, laparoscopic or robotic. Perioperative outcomes assessed were length of stay (LOS), 30-day and 90-day readmission rates, and complication rates

Results A total of 6803 DN were performed with urologists, transplant surgeons and general surgeons accounting for 42%, 29%, and 29% of them, respectively. Urologists performed a higher case volume with a mean surgical volume of 17.4 ± 6.5 per year ($p < 0.0001$). During the study period, case volumes for urologists and transplant surgeons trended upward, while those for general surgeons trended downward. Urologists also utilized a minimally invasive surgery (MIS) such as laparoscopy or robotic approach in a higher percentage of their cases ($p < 0.0001$). Regarding perioperative outcomes, general surgeons had a higher mean LOS ($p < 0.0001$), while transplant surgeons had higher rates of 30-day and 90-day readmission rates ($p < 0.0001$). There were no statistically significant differences in complication rates following DN among the groups.

Conclusion Urologists remain vital members of the renal transplantation team as they perform a majority of DN in NYS and are increasingly achieving them via an MIS approach when compared to their general and transplant surgery counterparts. Perioperative outcomes are similar amongst all disciplines; however, general surgeons have higher mean LOS, while transplant surgeons have higher readmission rates.

Keywords Donor nephrectomy · Minimally invasive surgery · Laparoscopic · Transplant · Kidney transplant

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Introduction

John Hartwell Harrison, a urologic surgeon, performed the first ever live donor nephrectomy in the U.S. in 1954 in conjunction with Drs. Murray and Merrill at the Brigham Hospital [1]. His pioneering work on donor nephrectomies (DN) established a foundation for future generations of urologists to build upon. However, other surgical specialists, general surgeons and transplant surgeons in particular, have also implemented DN in their practices.

The etiology of these trends among these surgical specialties is undoubtedly multifactorial; surgeon and patient preference, costs, availability of technology, geographic norms and institutional standards certainly affect the practice of medicine in our constantly evolving healthcare environment. For instance, as per the American Society of Transplant

Surgeons (ASTS), a recent review by the fellowship training committee in 2015 incorporated living donor nephrectomies into the accreditation portfolio. As a result, fellows in training programs will have increased exposure and experience with living donor nephrectomies.

In this study, we aim to study the trends in DN across different surgical disciplines, differences in perioperative outcomes, and trends in how these procedures are being performed with regard to open vs. minimally invasive surgical (MIS) approaches.

Materials and methods

We retrospectively reviewed all live donor nephrectomies reported in the Statewide Planning and Research Cooperative Systems (SPARCS) database of New York State (NYS) from 1995 to 2015. Surgeon specialties were identified from their NYS license number. We divided the physicians into three groups: urologic surgeons, transplant surgeons, and general surgeons. Primary endpoints assessed included length of stay, 30-day readmission rates, 90-day readmission rates, and complication rates. Secondary endpoints assessed variation in surgical technique, particularly open versus minimally invasive.

The Statewide Planning and Research Cooperative System (SPARCS) database was used to identify all donor nephrectomies in New York State by identifying patients with a primary diagnosis of kidney donor (ICD-9 code: V59.4) and procedure of nephroureterectomy (ICD-9 code: 55.51). Furthermore, we identified physicians in the database by their physician state license number and divided cases into groups based on physician specialty (Urology, General Surgery, and Transplant Surgery). Minimally invasive procedures were identified by the laparoscopic identifier (ICD-9 code: 5421). Pearson chi-square tests were used to compare categorical variables, and analysis of variance (ANOVA) was used for continuous variables.

Results

A total of 6803 donor nephrectomies were performed within the study period with urologists, transplant surgeons and general surgeons performing 42.5%, 29%, and 28.5%, respectively (Table 1). Urologists perform a significantly higher case volume of DN in NYS with a mean surgical volume of 17.4 ± 6.5 per year ($p < 0.0001$). Throughout the study period, the number of DN performed by urologists and transplant surgeons increased, as opposed to DN performed by general surgeons decreased (Fig. 1). Furthermore, urologists utilized a minimally invasive surgical approach in a higher percentage of their cases when compared to their

surgical counterparts ($p < 0.0001$). Urologists utilized a minimally invasive approach in 27% of their cases, as opposed to 21% by transplant surgeons and 23% by general surgeons and this trend is changing over time (Fig. 2).

With regards to perioperative outcomes, general surgeons had a significantly higher mean length of stay ($p < 0.0001$), while transplant surgeons had significantly higher rates of 30-day and 90-day readmission rates ($p < 0.0001$) (Table 2). General surgeons had a mean length of stay of 3.6 days, as opposed to urologic and transplant surgeons who had mean length of stays of 3.1 and 3.0 days, respectively. Transplant surgeons had the highest 30-day readmission rates, at a rate of 1.22%, as opposed to urologic and general surgeons, both of whom with rates of approximately 0.7%. Similar results were obtained for 90-day readmission rates, with transplant surgeons having the highest rate at 1.3%, as opposed to urologic and general surgeons, both of whom with rates of approximately 0.8%.

Complication rates were found to be 19.6%, 21.7%, and 19.8% among urologic, transplant, and general surgeons, respectively, although this finding did not reach statistical significance ($p = 0.16$).

Discussion

Though first pioneered by a urologic surgeon in 1954, a multitude of residency and fellowship pathways have enabled various surgical specialties to perform living donor nephrectomies. As highlighted by Novick in 1988, areas of low, moderate, and high urology resident exposure to renal transplantation were found in the 113 (of 123) approved urology residency training programs [2]. At that time, only 9% of programs were found to have no resident exposure to renal transplantation. In 1998, Navarrete revisited the issue of urology involvement in renal transplantation, and stated that American urologists have largely been replaced by transplant surgeons (mostly general surgeons) as the leaders in kidney transplant programs since the 1970s [3].

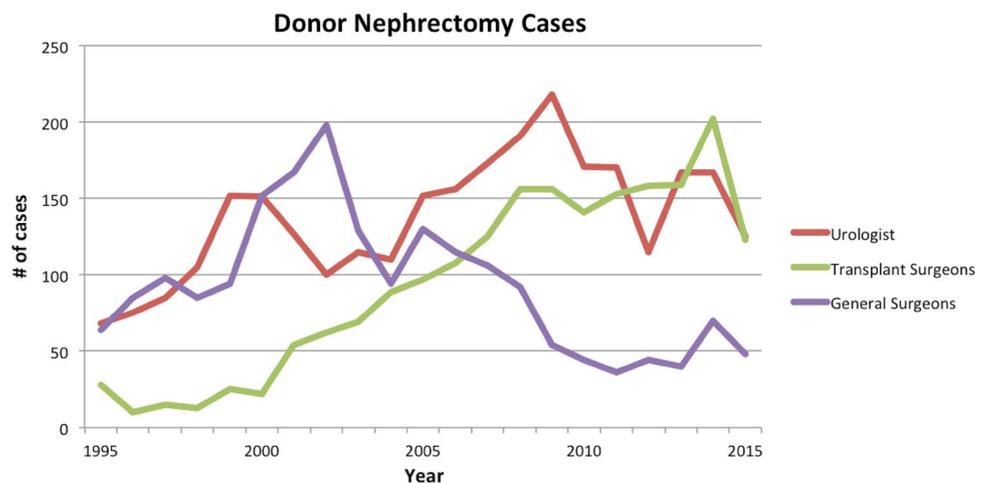
The changes in who is performing donor nephrectomies are still occurring today and have an impact on the technical approach to these surgeries based on physician comfort and preference. Our study shows differences in approach between the three surgical groups with urologists performing the most MIS donor nephrectomies (776; 27%) in the study period. A study from McGregor et al. analyzed urological involvement in renal transplant programs in Canada and found that of 59 transplant surgeons, 46% had graduated from a urology residency and 54% had a general surgery background [4]. In line with the findings of our study, they noted that transplant surgeons with a urologic background performed laparoscopic donor nephrectomies more than their general surgery trained colleagues.

Table 1 Comparison of demographic and patient characteristics

	Total donor nephrectomies			p value
	Urologist	Transplant surgeons	General surgeons	
Age	2893 (43%) 42.2 ± 12.0	1965 (30%) 40.9 ± 11.6	1945 (30%) 39.6 ± 11.2	< 0.0001
Gender				0.276
Male	1209 (42%)	811 (41%)	858 (44%)	
Female	1638 (58%)	1154 (59%)	1087 (56%)	
Race				< 0.0001
White	1837 (64%)	1259 (64%)	1165 (60%)	
Black	306 (11%)	251 (13%)	251 (13%)	
Asian	75 (3%)	41 (2%)	28 (1%)	
Other/Unknown	675 (23%)	414 (21%)	501 (26%)	
Average median income by zip code (\$)	80,030.26 ± 24,469.84	71,176.52 ± 21,061.09	73,652.82 ± 23,026.40	< 0.0001
Mean surgical volume per year	17.4 ± 6.5	9.9 ± 5.0	10.4 ± 3.6	< 0.0001
Mean hospital volume per year	24.6 ± 7.9	14.9 ± 8.9	14.4 ± 4.8	< 0.0001
CCI				0.754
0	2750 (95%)	1859 (95%)	1853 (95%)	
1	143 (5%)	103 (5%)	92 (5%)	
Approach				< 0.0001
Open	2117 (73%)	1550 (79%)	1496 (77%)	
Minimally invasive	776 (27%)	415 (21%)	449 (23%)	
Insurance status				< 0.0001
Private	1790 (62%)	1210 (62%)	1203 (62%)	
Medicare	536 (19%)	209 (11%)	385 (20%)	
Self-pay	484 (17%)	45 (2%)	164 (8%)	
Mean total charges (\$)	22,601.98 ± 13,255.51	30,266.22 ± 21,912.99	21,474.59 ± 13,553.12	< 0.0001
Median total charges (\$)	21,000	26,421.23	18,837.01	–

CCI Charlson Comorbidity Index, LOS length of stay

Fig. 1 Trends in donor nephrectomy cases among three surgical disciplines



Several studies have shown the efficacy of the laparoscopic approach to donor nephrectomy with reports of shorter hospital length of stay and lower intraoperative blood loss when compared to the open approach [5–7]. In particular, a recent publication in *Urology* highlighted

that laparoscopic donor nephrectomy was associated with shorter hospital stays, decreased pain scores, physical fatigue and increased physical function at six weeks post-operatively [8]. This does not obviate the role or need for open donor nephrectomies, as they are indicated in particular

Fig. 2 Percentage of open donor nephrectomy cases by years

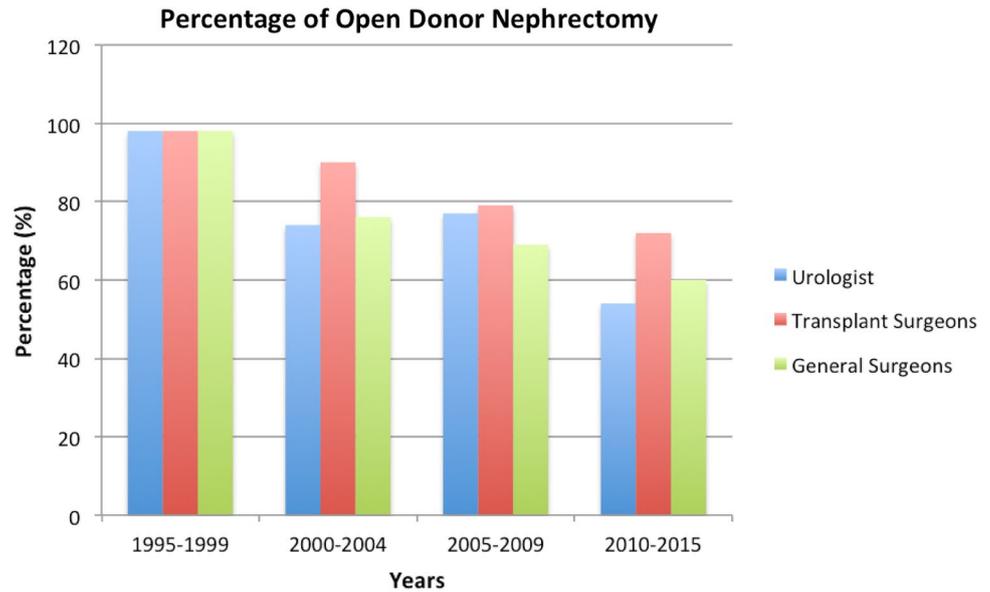


Table 2 Unadjusted outcomes of donor nephrectomy by subspecialty

	Total donor cases			p value
	Urologist	Transplant surgeon	General surgeons	
	2893 (43%)	1965 (30%)	1945 (30%)	
Mean LOS	3.1 ± 1.6	3.0 ± 1.6	3.6 ± 1.8	< 0.0001
Median LOS	3.0	3.0	3.0	–
30-Day readmission, no. (%)	20 (< 1%)	24 (1%)	13 (< 1%)	< 0.0001
90-Day readmission, no. (%)	22 (< 1%)	26 (1%)	15 (< 1%)	< 0.0001
# of patients with complications	567 (20%)	427 (22%)	385 (20%)	0.160

CCI Charlson Comorbidity Index, LOS length of stay

circumstances outside the scope of this article; however, it underscores the role of parameters other than surgeon preference on surgical decision making. Additionally, with advancements in minimally invasive surgery, robotic-assisted laparoscopic donor nephrectomy has become a reasonable alternative to the standard laparoscopic approach, as recently suggested in a manuscript from the *Journal of Robotic Surgery* [9]. Although warm ischemia and extraction times were longer in the robotic cohort, donor length of stay, estimated glomerular filtration rates (GFR) and complication rates were similar at 1 year in both cohorts. Other studies have reported similar findings showing decreased length of stay and an overall reduction in cost for robotic-assisted laparoscopic donor nephrectomy [10,11].

It is important to note that patient preference should be an important consideration in choosing between MIS and open donor nephrectomy. A study by Chung et al. assessed donor attitude and reasoning for selecting either laparoscopic or open nephrectomy and found that most patients, if given the option to choose between the two, chose MIS due to the ability of returning to work sooner and associated less

postoperative pain [12]. In our continuously evolving health-care society, greater emphasis on cost reduction, patient satisfaction, and patient quality of life have been placed on clinical providers as a means of measuring clinical performance.

To our knowledge, this is the first report analyzing trends and outcomes in donor nephrectomy procedures based on surgical subspecialty conducted in the U.S. Though our outcomes are limited to length of stay, complication, 30-day readmission, and 90-day readmission, we want to add our findings to the current literature assessing outcomes in donor nephrectomy. In our cohort, donor nephrectomies conducted by general surgeons had the longest length of stay at 3.6 ± 1.8 while urologist and transplant surgeons saw a shorter length of stay for their patients at 3.1 ± 1.6 and 3.0 ± 1.6 , respectively (Table 2). These results are comparable to other studies in the literature that report an average length of stay around between 3 and 5 days [13–15]. One potential reason for such a discrepancy could be the increased utilization of MIS approaches for urologists when conducting donor nephrectomies. A study by Tsoufas et al. showed that laparoscopic donor nephrectomy was associated

with a decreased length of stay when compared to the open approach [16]. Complication rates amongst surgeons in our study were similar between groups ($p=0.160$). Though 30- and 90-day readmission rates were statistically significant and in favor of general surgeons and urologists, we do not believe these findings to be clinically significant due to the low number of total readmissions over the study period.

Our trend analysis supports increased specialization in donor nephrectomy case volume in NYS. Transplant surgeons and Urologists have increased their number of donor nephrectomy cases as general surgeons are doing less of these procedures in the most recent years (Fig. 1). These changing practice patterns are multifactorial and include urbanization, changes in technology, changes in patient and provider preference. The importance of these findings cannot be overlooked in reference to residency training and exposure to transplantation for urologists and transplant surgery fellows.

Our study has several strengths. It utilizes the SPARCS database which is a multi-payer database that mandates by law the collection of certain data from all inpatient encounters in New York State. New York State is the 3rd largest center in terms of healthcare in the U.S. and is likely a macrocosm for other states and regions. Our study also takes into account 20-year trends in donor nephrectomy procedures which provide a large sample size of where trends have been in the past and where they may be going in the future. It is important to note, however, that the trends and outcomes we highlight in this manuscript correspond to living donor nephrectomies only in New York State. As briefly mentioned in the introduction, geography plays a role in trends involving various surgical specialties and donor nephrectomy. Navarrete noted that the entire kidney transplant program was overseen by urologists in Spain⁴. This is not the case for all countries. Additionally, our study lacks any clinicopathological data that would improve our analysis of outcomes between surgical groups. Specifically, 30- and 90-day readmission can be impacted by several factors outside of the independent surgeon's ability or skill as transplant surgery involves a multi-disciplinary team. We believe that surgical experience and training are associated with improved outcomes in donor nephrectomy and subsequent studies on this topic need to be conducted to further characterize outcome disparities between the cohorts.

Conclusions

Urologic surgeons remain an important and integral member of the kidney transplantation team as they perform a majority of DN and are increasingly performing them via a laparoscopic or robotic approach when compared to their transplant surgery and general surgery counterparts. Further

studies will need to be conducted to highlight the shift in surgical approach to donor nephrectomies in light of new policies, patient satisfaction scores, and healthcare costs.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no competing interest.

Research involving human participants and/or animals Human.

Informed consent N/A (retrospective).

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