World Journal of Surgery

Journal Homepage: surgeryworld.org

Research Article

Retroperitoneoscopic Versus Open Polycystic Nephrectomy and Simultaneous Transplantation for Patients with End Stage Renal Disease from Polycystic Kidney Disease

Phyu Cin Thant*, Manjunath Pol, Santosh A Olakkengil and Shantanu Bhattacharjya

Central and Northern Adelaide Renal and Transplantation Service, Australia

ARTICLE INFO

Article history:
Received: 22 December, 2023
Accepted: 16 January, 2024
Published: 31 January, 2024

Keywords:
Polycystic kidney disease, laparoscopic nephrectomy, open nephrectomy, simultaneous renal transplant

ABSTRACT

Introduction: Patients with end stage autosomal dominant polycystic kidney disease (ADPKD) requiring kidney transplantation may require nephrectomy for symptomatic or space compromising large polycystic kidneys. Polycystic nephrectomy with simultaneous kidney transplantation is not a commonly performed. This can be done via laparoscopic or open laparotomy. In this audit, the outcomes of retroperitoneoscopic unilateral nephrectomy and simultaneous transplant (RUNST) and open bilateral nephrectomy and simultaneous transplant (OBNST) performed at our centre are compared. The authors are not aware of any series that has described the outcomes of a retroperitoneoscopic approach for this condition. **Method:** Retrospective analysis of patients undergoing polycystic nephrectomy with simultaneous kidney transplant surgery for the past 3 years is undertaken. Clinical data and graft outcome parameters were analysed to determine technical safety, feasibility, and outcomes. **Results:** Nine patients underwent polycystic nephrectomy and simultaneous kidney transplant surgery between 2020 and 2023. Five patients underwent RUNST and four underwent OBNST. Six were live donor transplants, and three were deceased donor transplants. Odds ratio for requiring ICU stay is 4.5 times in OBNST group compared to the RUNST group. The duration of hospital admission (8 days vs 5.7 days), ICU stay (3 days vs 1 day), and the need for blood transfusion (7.7 units vs 4.5 units) are compared between OBNST and RUNST. Statistical analysis shows that these differences are statistically insignificant between the two groups. Except for the delayed graft function among deceased donor recipients, the rest of the outcomes with respect to graft function were comparable between the two groups. **Conclusion:** A simultaneous approach is safe without increased length of stay. The need for blood transfusion is no greater than patients having a staged nephrectomy prior to transplantation. None of the patients developed donor specific antibodies. The post-operative outcomes of RUNST versus OBNST were comparable, with no major adverse complications.

1. Introduction

The prevalence of autosomal dominant polycystic kidney disease (ADPKD), a multisystem hereditary disorder, is thought to be 1 in 1000 cases [1, 2]. It leads to formation of cysts causing functional impairment and end stage renal disease (ESRD). The start of renal impairment can occur at any age, by the age of 60, about 50% of ADPKD's would require renal replacement therapy and 20% would require native nephrectomy [3].

Polycystic nephrectomy is generally indicated for symptomatic kidneys or if there is insufficient space for implanting graft kidney owing to their large size. This could be performed either by minimal invasive or open technique. The latter needs an extensive subcostal or midline incision [4]. Wound dehiscence and incisional hernias are far more common in transplant patients on immunosuppressants [5]. Patients on steroids or anti-proliferative medicines (sirolimus or everolimus) have a significant impact on wound healing [6, 7]. The greatest benefit of minimal invasive surgery among transplant patients is absence of incisional hernia.

The history of minimal invasive surgery in transplantation began with laparoscopic fenestration for lymphocele in 1991, followed by laparoscopic donor nephrectomy and laparoscopic polycystic nephrectomy in PCKD in 1995 and 1996 respectively [8-10]. When compared to normal sized kidney, laparoscopic (transperitoneal) nephrectomy (LN) for ADPKD is technically challenging due to the

*Correspondence to: Phyu Cin Thant, Central and Northern Adelaide Renal and Transplantation Service, Australia; E-mail: phyucin.thant@sa.gov.au

DOI: 10.60123/j.WJS.2023.30.06

massive size of these kidneys, and the limited operative space [11-13]. Since the first description of LN by Elashry *et al.* several centres have performed bilateral LN in a small number of cases and demonstrated its safety and feasibility, and better short-term outcomes [14-17]. However, LN would need a separate incision for specimen retrieval and graft implantation that could otherwise be managed through the same incision in a retroperitoneoscopic approach.

To our surprise, there is lack of data regarding safety and efficacy of retroperitoneoscopic polycystic nephrectomy and simultaneous transplantation in the english literature. Therefore, purpose of this audit was to compare the outcomes of the retroperitoneoscopic versus open polycystic nephrectomy and simultaneous transplant.

2. Methodology

A retrospective audit of a prospectively maintained database of patients that underwent polycystic nephrectomy and simultaneous transplant from July 2020 to June 2023 was carried out to determine the technical safety, feasibility, and impact on clinical and graft outcomes. Clinical data detailing surgical approach (retroperitoneoscopic vs open), nephrectomies (single vs bilateral), donor type (living vs deceased), total ischaemic time, operative time, intensive care input, length of stay, surgical complications, time to graft function, perioperative transfusion requirements and postoperative outcome are assessed. Postoperative complications are determined based on Clavien-Dindo classification system.

2.1. Inclusion Criteria

i) 18 to 70 years of age, both male and female.
ii) Symptomatic PCKD: any one of the below
- Abdominal pain
- Haematuria
- Haemorrhage
- Nephrolithiasis
- Recurrent urinary tract infection (≥ two episodes)
- Malignancy

iii) Large size reaching below pelvis compromising space for graft transplantation.

2.2. Exclusion Criteria

i) Age < 18 years
ii) Pregnant females
iii) Staged polycystic nephrectomy and transplant
iv) Un-correctable cardiac illness
v) Previous transplant
vi) Prior abdominal surgery

2.3. Statistical Analysis

The entire data was tabulated in the MS-Excel 2016 datasheet. Continuous variables were expressed as the mean ± standard deviation (SD), or median (Interquartile range [IQR]), as appropriate. Descriptive statistics and frequencies were obtained and compared using the SPSS version 25.0 statistical package (IBM Statistics, New York, USA). Statistically significant differences between randomization groups were assessed using the Pearson $\chi 2$ test or the Fisher exact test for categorical variables. Wilcoxon rank-sum test was used for the analysis of continuous variables with non-parametric data.

2.4. Surgical Technique

Laparoscopic retroperitoneoscopic polycystic nephrectomy (RN) was performed in a lateral position with elevation of the lumbar bridge. A balloon was introduced into the extra-peritoneal plane with an open approach, with an appropriately sized incision placed about 2 fingers breadth superomedial to the anterior superior iliac spine and inflated to create the retroperitoneal space. This was then replaced with a 10-12mm balloon port (optical port Applied Medical™) with carbon dioxide insufflation at 12mmHg. Two working ports were introduced under vision: one in the renal angle and another at the junction of the mid-axillary line and the 12th costal cartilage with an additional 5 mm port used for retraction, if necessary, along the anterior axillary line in the line of the 12th or 11th costal cartilage (Figure 1). The psoas was identified as a band of horizontally running muscle fibres and followed medially to the renal vein and renal artery. These were dissected free and controlled with haemolocks (Weck Teleflex™) and stapled and divided using Covidien Endo GIA™ tan 45 vascular stapling and cutting device. Following vascular control, the fascia of gerota was entered and the polycystic kidney is dissected free. The ureter-gonadal vein complex was stapled and cut. After complete haemostasis was achieved, the camera port incision was extended towards pubic symphysis keeping extra-peritoneal and the specimen was delivered. The patient's position is changed to supine and draped again. The graft kidney vessels are anastomosed to the iliac vessels and neocystoureterostomy performed.

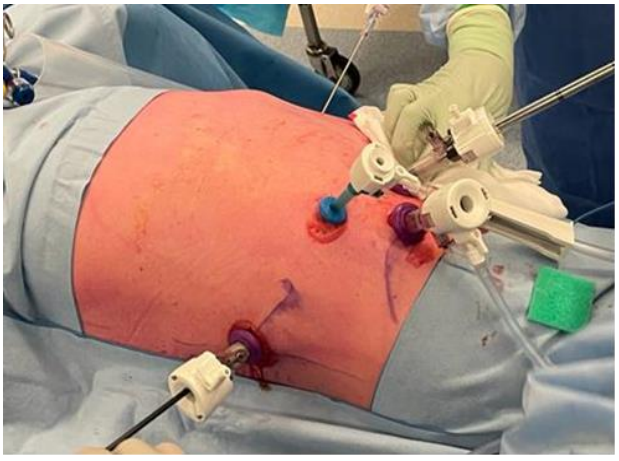

FIGURE 1: Port placement in retroperitoneoscopic polycystic nephrectomy.

3. Results

A total of nine patients underwent combined polycystic nephrectomy and kidney transplant surgery between July 2020 and June 2023. All the clinical and graft outcome parameters were compared between laparoscopic retroperitoneoscopic unilateral nephrectomy and simultaneous transplant (RUNST) and open bilateral nephrectomy and simultaneous transplant (OBNST). Of these, five patients underwent RUNST (four of whom received living donor transplant, and one

received deceased donor transplant); and four underwent OBNST (two each for living donor and deceased donor transplants) for symptomatic ADPKD. Table 1 shows parameters compared between RUNST and OBNST. Table 2 shows parameters compared between living and deceased donor transplants. Immediate good graft function was seen in live donor transplants and delayed graft function was noted in the deceased donor transplants. The mean serum creatinine at end of post-operative day-5 in living donor transplants was 170 umol/L and in deceased donor transplants was 783 umol/L. The mean serum creatinine at the end post-operative day-5 in RUNST and OBNST was 250 and 531 umol/L respectively. Time taken by the deceased donor kidneys to develop graft function was between 10-14 days. Average weight and average cranio-caudal length of the specimen removed in RUNST and OBNST was 2.02 kg and 22 cm; and 2.95 kg and 19.3 cm respectively, with an average cranio-caudal length of 20 cm. Total ischaemic time ranges from 1.22 hours to 14.38 hours, with the mean total ischaemic time for live donor transplants being 4.26 ± 1.97 hours; and the mean total ischaemic time for cadaveric transplants being 12.22 ± 2.26 hours. Average blood transfusion required perioperatively were 4.5 units for RUNST group and 7.7 units for OBNST group. None of these patients have developed donor specific antibodies post-transplant. There were 5 patients out of the total 9 who required postoperative ICU stay. 2 of them where from RUNST group, and 3 of them from OBNST group. The odds of requiring ICU input after an open bilateral procedure is 4.5 times that of a unilateral retroperitoneoscopic procedure (p value <0.52). The median length of stay in ICU was 3 days. Length of admission ranges from 3 to 10 days post operatively, with the average length of stay in hospital for RUNST being 5.7 days, and for OBNST being 8 days. However, there is no statistically significant difference in the length of stays between RUNST and OBNST groups.

TABLE 1: Comparison of parameters between RUNST and OBNST.

Parameters	RUNST (n = 5)	OBNST (n = 4)
Average weight of the specimen (KG)	2.02 (±2.5)	2.95 (±0.6)
Average cranio-caudal length (CM)	22 (±1.8)	19.3 (±1.4)
Live donor transplants (n)	4	2
Deceased (cardiogenic death) transplant (n)	1	2
Total ischemia time (CIT + WIT) (hours)	6.35 (± 1.58)	7.81 (± 5.96)
Immediate graft function - good	4	2
Delay graft function (n)	1	2
Mean serum creatinine on POD-5 (UMOL/L)	249.8 (±240.8)	530.7 (±337.2)
Operative time (hours, mean)	4.28 (± 0.81)	5.78 (± 0. 99)
Perioperative transfusion requirement (units, mean)	4.5 (± 3.9)	7.7 (± 6.9)
ICU stay (days, mean)	2 patients required 0.8 (± 1.1)	3 patients required 3 (± 1.1)
Duration of hospital stay (days, mean)	5.7 (± 1.7)	8 (± 2.3)
Scar dimension	10 cm	25 cm

TABLE 2: Comparison of parameters between live donors and deceased donors.

Parameters	Live donors (n =6)	Deceased donors (n=3)
Mean total ischaemic time (hours)	4.26 (±1.97)	12.22 (±2.26)
Total operative time (hours)	4.6 (±0.65)	6.2 (±1.01)
Mean serum creatinine on POD-5 (umol/l)	170.1 (± 75.2)	782.7 (± 158.7)
Delay graft function (n)	0	3

There was no case of graft thrombosis noted within our cohort. All were followed up to 3-months post-surgery. Standard postoperative care was provided. Postoperative complication numbers according to Clavien Dindo classification is listed in (Table 3).

TABLE 3: Comparison of number of complications between RUNST and OBNST as per Clavien-Dindo classification.

Clavien-Dindo classification	RUNST	OBNST
Before discharge		
Grade 3a	0	0
Grade 3b	1	1
Grade 4a	2	3
Grade 4b	0	0
Discharge to 90 days		
Grade 3a	2	1
Grade 3b	1	1

Grade 4a	0	0
Grade 4b	0	0

The patients in this study were followed up to 3 months post operation, and the complications listed as per the Clavien-Dindo classification. The grade 3 and 4 complications of the cohort in this case study are further described in (Table 4) below.

TABLE 4: Details of complications.

Clavien-Dindo classification	RUNST	OBNST
Before discharge		
Grade 3b	1. Return to theatre at day 1 post op for intra-abdominal bleed from staple line failure at the nephrectomy site.	1. Return to theatre at day 0 post op for intra-abdominal bleed from an adventitial branch of a lower pole artery of transplant kidney
Grade 4a	1. Required ICU input for post-op hypotension requiring vasopressor support. 2. Required ICU input for haemorrhagic shock following return to theatre for staple line failure.	1. Required ICU input for vasopressor support and monitoring following return to theatre for bleeding. 2. Required ICU input for post-op hypotension and hyperkalaemia requiring vasopressor support and dialysis. 3. Required ICU input for vasopressor support for hypotension secondary to intraoperative bleeding and vasoplegia post operatively.
Discharge to 90 days		
Grade 3a	1. Required nephrostomy and re-insertion of ureteric stent 3 weeks post op following an acute kidney injury post initial stent removal. 2. Small urine leak noted on MAG3 scan at 2 weeks post op, treated with IDC insertion.	1. 2 re-admissions at day 15 and 50 from acute kidney injury and hydronephrosis requiring nephrostomy and ureteric stent insertion.
Grade 3b	1. Obstructive uropathy from lymphocele requiring laparoscopic fenestration procedure at 4 weeks post op.	1. Obstructive uropathy from lymphocele requiring laparoscopic fenestration procedure at day 80 post op.

4. Discussion

Polycystic nephrectomy is indicated when symptomatic or when there is insufficient space for renal transplantation surgery. Symptoms may be confined to renal or extra renal complications such as, pain, recurrent urinary tract infections, haematuria, urolithiasis, and rarely malignancy [18]. Trans-peritoneal route is considered technically more convenient than the retroperitoneoscopic approach for polycystic nephrectomy. Retroperitoneoscopic approach offers minimal operating space for nephrectomy and is technically more challenging. The largest specimen that was retrieved through a modified Gibson incision in this case series was 4.3 kgs. A similar approach was advocated by Gill *et al.* and retrieved a kidney weighing 2.6 kg [14].

The advantage of retroperitoneoscopic approach includes direct access to renal vessels leading to early ligation and reduced chances of bleeding. Some surgeons advocated cyst puncture to reduce kidney volume; nevertheless, it was deemed risky since it could cause peritonitis like symptoms or lead to prolonged ileus because most cyst fluid was infectious [18, 19]. Similarly, there were some concerns about contamination during RUNST performed through the same incision. In our study, however, kidney allografts transplanted in the extra-peritoneal space in the right iliac fossa did not have increased risk of infection. Because LN is performed by trans-peritoneal approach and RN is performed through retroperitoneal approach, the retroperitoneoscopic approach may be a better alternative to avoid infection [20]. Concurrently, recent studies on laparoscopic polycystic nephrectomy have concluded that there is no increased risk of infection when specimen was retrieved through a trans-peritoneal incision [21].

Injury to surrounding structures has been reported in both open and laparoscopic series [21-23]. In our series there was a small opening in the peritoneum in one case; however, there was no injury to the bowel. The conversion rates in early series of LN ranged between 3.4% and 22%; therefore, it was recommended to avoid laparoscopic approach when kidney size exceeded 3.5 kgs [21, 24]. A size of over 3.5 kgs (34/102; 33.3%) of the patients was reported by Binsaleh S, *et al.*, Uro 2006 and Verhoest G, *et al.*, JSLS 2011 during LN for symptomatic PCKD. Furthermore, they documented that there were no conversions and concluded that large size was not a contraindication [21, 25, 26].

The size and weight of kidneys were similar in our series compared to previously published reports of LN and there was no conversion in retroperitoneoscopic group. All the living donor kidney recipients were assessed in clinic where the decision for simultaneous nephrectomy and transplant was made pre-operatively. Five out of the six living donor kidney recipients were planned for a simultaneous retroperitoneoscopic unilateral nephrectomy, however one of these patients on the day of surgery was reassessed and operative plan was changed to simultaneous open bilateral nephrectomies. The sixth patient was planned for simultaneous open bilateral nephrectomies and transplant due to bilateral symptomatic and large polycystic kidneys.

In deceased donor kidney recipients, the decision for operative approach was made on assessment at the time of presentation for the transplant. Out of the three deceased donor kidney recipients, one had a retroperitoneoscopic unilateral nephrectomy at the time of transplantation due to lack of space for the transplant kidney. The reasons for open bilateral nephrectomies in the other two patients were because one received bilateral deceased donor kidneys, and the other patient had a larger native polycystic kidney at the site for transplant (right) and a more symptomatic polycystic kidney on the contralateral side.

The duration of surgery in RUNST group was 4.28 hours versus in 5.78 hours in OBNST. Although none of the retroperitoneoscopic cases required conversion, it appeared that the retroperitoneoscopic technique added 45 minutes to operative time since it required patient repositioning. These manoeuvres are not necessary while performing transperitoneal LN or hand assisted LN, which may reduce operative and anaesthetic time. Considering the lengthier operative time, limited operative space and potential risk of injury to the intra-abdominal organs, a few surgeons advocated hand assisted LN for bilateral polycystic nephrectomy [19]. Nunes *et al.* performed open unilateral nephrectomy and transplant through extended transplant incision [27]. In this case series we performed unilateral retroperitoneoscopic nephrectomy using single incision for specimen extraction and transplantation. This had a better cosmetic satisfaction when compared to open group (Figure 2).

FIGURE 2: Incision for specimen extraction and transplantation in RUNST.

The timing (staged or simultaneous) for polycystic nephrectomy and transplantation for PCKD has been a topic of debate, with each approach carrying its own risks and benefits [28, 29]. Multiple factors need to be considered at the time of kidney transplantation. Simultaneous nephrectomy with transplantation avoids dialysis when patients are pre-dialysis, does not subject the recipient to fluid restriction that becomes necessary with a staged approach, improves quality of life, and eliminates the need for two separate surgical procedures. Also, use of immunosuppressants during transplantation reduces the risk of sensitization if blood transfusion is required.

In this case series we saw that there was no effect on the clinical and graft function either in RUNST or OBNST groups. The patients with high-risk cardiovascular comorbidity were taken up for staged procedure, therefore, excluded from this study. A study by Grodstein *et al.* 2017 reported an increased risk of graft thrombosis in the simultaneous group when compared to staged group (4% vs 1%, respectively). On contrary, a systematic review by Xu *et al.* 2022 did not find increased risk of graft thrombosis [30, 31]. There was no graft thromboses noted in this series.

Hypotension due to haemorrhage is more likely during the surgery, however, hypotension following bilateral nephrectomy can also be related to a drop in renin-angiotensin levels. The latter is more pronounced in patients that remain anephric (non-functioning kidneys) and in those undergoing staged transplant. The mean blood transfusion rate in RUNST was 4.5 units and that in OBNST was 7.7 units. However, because of a small sample size, these differences were statistically not significant.

In a study reported by Eng M, *et al.*, JSLS. 2013 and Wu W-C, *et al.*, Ann surg. 2010 it is suggested that the patients undergoing LN had reduced blood loss and lesser post-operative morbidity and mortality [21, 32]. Furthermore, patients who have been sensitized following blood transfusion may have difficulty locating compatible organs [33-35]. None of these patients who had undergone polycystic nephrectomy and simultaneous kidney transplant have developed donor specific antigens in their follow-up.

In the study published by Glassman DT, *et al.*, J Urol. 2000 comparing open versus laparoscopic nephrectomy it was reported that number of blood transfusion (2.3 versus 1.0 units), operative time (452 versus 296 minutes), and duration of hospital stay was more in the open group when compared to LN technique [22]. Similarly, several studies have reported that the LN group had significantly lesser complications than the open nephrectomy group; however, there was no significant difference between hand assisted LN and open nephrectomy [13, 36-38]. The length of admission between RUNST and OBNST in our study was 5.7 days and 8 days respectively. A study published by Martin AD, *et al.*, BJU Int. 2012 reported that the average hospital stay for the combined procedure was one day longer than those underwent kidney transplant alone [26]. Within our unit, all transplant patients are managed using a standardised enhanced recovery after surgery (ERAS) protocol [39]. The length of stay of these patients undergoing simultaneous nephrectomy and transplants was not significantly longer from the rest of the cohort having transplant surgery alone (median length of 5 days).

Except for the delayed graft function among deceased donor transplants, rest outcomes with respect to the graft function were comparable between the two groups (live versus deceased donor). The patients in this case series at their most recent follow-up appointments, which vary from 2.5 years to 6 months post op, describe feeling well with stable and excellent graft function.

5. Conclusion

There is 100% graft and patient survival for all nine patients who have undergone polycystic nephrectomy and simultaneous kidney transplant at our centre. RUNST when compared to OBNST is safe and feasible with comparable graft outcomes in experienced hands. The need for blood transfusion is no greater than patients having a staged nephrectomy prior to transplantation, and no patients developed donor specific antibodies. Though there are higher odds of intensive care unit admission with OBNST, our case series have found it to be statistically insignificant. However, careful consideration should be undertaken into selecting the appropriate surgical approach to each patient.

Limitations

Small numbers in a single centre limit achieving enough power to reach statistically significant results. Data analysis is dependent on recorded retrospective data and therefore may contain some inaccuracies. Selection of the patients for simultaneous nephrectomy with transplant procedures are carefully considered and therefore may potentially be biased, and heterogeneity between groups may also affect the results. Operator bias is also present as the simultaneous procedure is only offered by two out of three surgeons in the unit.

REFERENCES

[1] F Davies, G A Coles, P S Harper, et al. "Polycystic kidney disease re-evaluated: a population-based study." *Q J Med*, vol. 79, no. 290, pp. 477-485, 1991. View at: Publisher Site | PubMed

[2] M Levy, J Feingold "Estimating prevalence in single-gene kidney diseases progressing to renal failure." *Kidney Int*, vol. 58, no. 3, pp. 925-943, 2000. View at: Publisher Site | PubMed

[3] P Patel, C Horsfield, F Compton, et al. "Native nephrectomy in transplant patients with autosomal dominant polycystic kidney disease." *Ann R Coll Surg Engl*, vol. 93, no. 5, pp. 391-395, 2011. View at: Publisher Site | PubMed

[4] A H Bennett, W Stewart, J M Lazarus "Bilateral nephrectomy in patients with polycystic renal disease." *Surg Gynecol Obstet*, vol. 137, no. 5, pp. 819-820, 1973. View at: PubMed

[5] Patrick G Dean, William J Lund, Timothy S Larson, et al. "Wound-healing complications after kidney transplantation: a prospective, randomized comparison of sirolimus and tacrolimus." *Transplantation*, vol. 77, no. 10, pp. 1555-1561, 2004. View at: Publisher Site | PubMed

[6] Stuart M Flechner, Lingmei Zhou, Ithaar Derweesh, et al. "The impact of sirolimus, mycophenolate mofetil, cyclosporine, azathioprine, and steroids on wound healing in 513 kidney-transplant recipients." *Transplantation*, vol. 76, no. 12, pp. 1729-1734, 2003. View at: Publisher Site | PubMed

[7] A Mehrabi, H Fonouni, M Wente, et al. "Wound complications following kidney and liver transplantation." *Clin Transplant*, vol. 20 Suppl 17, pp. 97-110, 2006. View at: Publisher Site | PubMed

[8] C S McCullough, N J Soper, R V Clayman, et al. "Laparoscopic drainage of a posttransplant lymphocele." *Transplantation*, vol. 51, no. 3, pp. 725-727, 1991. View at: Publisher Site | PubMed

[9] L E Ratner, L J Ciseck, R G Moore, et al. "Laparoscopic live donor nephrectomy." *Transplantation*, vol. 60, no. 9, pp. 1047-1049, 1995. View at: PubMed

[10] O M Elashry, S Y Nakada, J S Wolf Jr, et al. "Laparoscopy for adult polycystic kidney disease: a promising alternative." *Am J Kidney Dis*, vol. 27, no. 2, pp. 224-233, 1996. View at: Publisher Site | PubMed

[11] Fouad T Chebib, Mikel Prieto, Yeonsoon Jung, et al. "Native Nephrectomy in Renal Transplant Recipients with Autosomal Dominant Polycystic Kidney Disease." *Transplant Direct*, vol. 1, no. 10, pp. e43, 2015. View at: Publisher Site | PubMed

[12] Saleh Binsaleh, Ahmed Al-Enezi, Jihao Dong, et al. "Laparoscopic nephrectomy with intact specimen extraction for polycystic kidney disease." *J Endourol*, vol. 22, no. 4, pp. 675-680, 2008. View at: Publisher Site | PubMed

[13] Saleh Binsaleh, Patrick P Luke, Christopher Nguan, et al. "Comparison of laparoscopic and open nephrectomy for adult polycystic kidney disease: operative challenges and technique." *Can J Urol*, vol. 13, no. 6, pp. 3340-3345, 2006. View at: PubMed

[14] I S Gill, J H Kaouk, M G Hobart, et al. "Laparoscopic bilateral synchronous nephrectomy for autosomal dominant polycystic kidney disease: the initial experience." *J Urol*, vol. 165, no. 4, pp. 1093-1098, 2001. View at: PubMed

[15] Pengyu Guo, Wanhai Xu, Huibo Li, et al. "Laparoscopic Nephrectomy versus Open Nephrectomy for Patients with Autosomal Dominant Polycystic Kidney Disease: A Systematic Review and Meta-Analysis." *PLoS One*, vol. 10, no. 6, pp. e0129317, 2015. View at: Publisher Site | PubMed

[16] P Ungbhakorn, W Kongchareonsombat, C Leenanupan, et al., "Comparative outcomes of open nephrectomy, hand-assisted laparoscopic nephrectomy, and full laparoscopic nephrectomy for living donors." Transplant Proc, vol. 44, no. 1, pp. 22-25, 2012. View at: Publisher Site | PubMed

[17] Christopher Springer, M Raschid Hoda, Harun Fajkovic, et al. "Laparoscopic vs open partial nephrectomy for T1 renal tumours: evaluation of long-term oncological and functional outcomes in 340 patients." *BJU Int*, vol. 111, no. 2, pp. 281-288, 2013. View at: Publisher Site | PubMed

[18] Y Bendavid, H Moloo, L Klein, et al. "Laparoscopic nephrectomy for autosomal dominant polycystic kidney disease." *Surg Endosc*, vol. 18, no. 5, pp. 751-754, 2004. View at: Publisher Site | PubMed

[19] David I Lee, Ralph V Clayman "Hand-assisted laparoscopic nephrectomy in autosomal dominant polycystic kidney disease." *J Endourol*, vol. 18, no. 4, pp. 379-382, 2004. View at: Publisher Site | PubMed

[20] Jonathan L Wright, James R Porter "Laparoscopic partial nephrectomy: comparison of transperitoneal and retroperitoneal approaches." *J Urol*, vol. 174, no. 3, pp. 841-845, 2005. View at: Publisher Site | PubMed

[21] Mary Eng, Christopher M Jones, Robert M Cannon, et al. "Hand-assisted laparoscopic nephrectomy for polycystic kidney disease." *JSLS*, vol. 17, no. 2, pp. 279-284, 2013. View at: Publisher Site | PubMed

[22] D T Glassman, L Nipkow, S T Bartlett, et al. "Bilateral nephrectomy with concomitant renal graft transplantation for autosomal dominant polycystic kidney disease." *J Urol*, vol. 164 no. 3 Pt 1, pp. 661-664, 2000. View at: Publisher Site | PubMed

[23] Andrew Kramer, Justin Sausville, Abdolreza Haririan, et al. "Simultaneous bilateral native nephrectomy and living donor renal

transplantation are successful for polycystic kidney disease: the University of Maryland experience." *J Urol*, vol. 181, no. 2, pp. 724-728, 2009. View at: Publisher Site | PubMed

[24] Michael C Lipke, Vladislav Bargman, Martin Milgrom, et al. "Limitations of laparoscopy for bilateral nephrectomy for autosomal dominant polycystic kidney disease." *J Urol*, vol. 177, no. 2, pp. 627-631, 2007. View at: Publisher Site | PubMed

[25] Eric S Wisenbaugh, Mark D Tyson 2nd, Erik P Castle, et al. "Massive renal size is not a contraindication to a laparoscopic approach for bilateral native nephrectomies in autosomal dominant polycystic kidney disease (ADPKD)." *BJU Int*, vol. 115, no. 5, pp. 796-801, 2015. View at: Publisher Site | PubMed

[26] Aaron D Martin, Kristin L Mekeel, Erik P Castle, et al. "Laparoscopic bilateral native nephrectomies with simultaneous kidney transplantation." *BJU Int*, vol. 110, no. 11 Pt C, pp. E1003-E1007, 2012. View at: Publisher Site | PubMed

[27] P Nunes, A Mota, R Alves, et al. "Simultaneous renal transplantation and native nephrectomy in patients with autosomal-dominant polycystic kidney disease." *Transplant Proc*, vol. 39, no. 8, pp. 2483-2485, 2007. View at: Publisher Site | PubMed

[28] Chrysoula Argyrou, Demetrios Moris, Spyridon Vernadakis, et al. "Tailoring the 'Perfect Fit' for Renal Transplant Recipients with End-stage Polycystic Kidney Disease: Indications and Timing of Native Nephrectomy." *In Vivo*, vol. 31, no. 3, pp. 307-312, 2017. View at: Publisher Site | PubMed

[29] T Florian Fuller, Todd V Brennan, Sandy Feng, et al. "End stage polycystic kidney disease: indications and timing of native nephrectomy relative to kidney transplantation." *J Urol*, vol. 174, no. 6, pp. 2284-2288, 2005. View at: Publisher Site | PubMed

[30] Elliot I Grodstein, Nathan Baggett, Shawn Wayne, et al. "An Evaluation of the Safety and Efficacy of Simultaneous Bilateral Nephrectomy and Renal Transplantation for Polycystic Kidney Disease: A 20-Year Experience." *Transplantation*, vol. 101, no. 11, pp. 2774-2779, 2017. View at: Publisher Site | PubMed

[31] Josephine Xu, Kenneth D'Souza, Ngee Soon Lau, et al. "Staged versus concurrent native nephrectomy and renal transplantation in patients with autosomal dominant polycystic kidney disease: A systematic review." *Transplant Rev (Orlando)*, vol. 36, no. 1, pp. 100652, 2022. View at: Publisher Site | PubMed

[32] Wen-Chih Wu, Tracy S Smith, William G Henderson, et al. "Operative blood loss, blood transfusion, and 30-day mortality in older patients after major noncardiac surgery." *Ann Surg*, vol. 252, no. 1, pp. 11-17, 2010. View at: Publisher Site | PubMed

[33] J C Scornik, W W Pfaff, R J Howard, et al. "Increased antibody responsiveness to blood transfusions in pediatric patients." *Transplantation*, vol. 58, no. 12, pp. 1361-1365, 1994. View at: PubMed

[34] J C Scornik, J E Ireland, R J Howard, et al. "Assessment of the risk for broad sensitization by blood transfusions." *Transplantation*, vol. 37, no. 3, pp. 249-253, 1984. View at: Publisher Site | PubMed

[35] M Ghio, P Contini, C Mazzei, et al. "Soluble HLA class I, HLA class II, and Fas ligand in blood components: a possible key to explain the immunomodulatory effects of allogeneic blood transfusions." *Blood*, vol. 93, no. 5, pp. 1770-1777. View at: PubMed

[36] P A Gabow "Autosomal dominant polycystic kidney disease." *N Engl J Med*, vol. 329, no. 5, pp. 332-342, 1993. View at: Publisher Site | PubMed

[37] Grégory Verhoest, Arnaud Delreux, Romain Mathieu, et al. "Transperitoneal laparoscopic nephrectomy for autosomal dominant polycystic kidney disease." *JSLS*, vol. 16, no. 3, pp. 437-442, 2012. View at: Publisher Site | PubMed

[38] P A Seshadri, E C Poulin, D Pace, et al. "Transperitoneal laparoscopic nephrectomy for giant polycystic kidneys: a case control study." *Urology*, vol. 58, no. 1, pp. 23-27, 2001. View at: Publisher Site | PubMed

[39] Brendan H Dias, Abdul Ahad Muhammad Rana, Santosh A Olakkengil, et al. "Development and implementation of an enhanced recovery after surgery protocol for renal transplantation." *ANZ J Surg*, vol. 89, no. 10, pp. 1319-1323, 2019. View at: Publisher Site | PubMed