RESEARCH ARTICLE JSLS

Midline Rotation of the Right Renal Hilum During Hand-Assisted Laparoscopic Living Donor Nephrectomy

Gaetano Ciancio, MD, Ahmed Farag, MD, PhD, Jeffrey J. Gaynor, PhD, Mahmoud Morsi, MD, Linda Chen, MD, George W. Burke III, MD

ABSTRACT

Background/Objectives: Laparoscopic living donor nephrectomy (LLDN) of the right kidney is currently considered as part of standard of care; however, dealing with the renal hilum when performing ligation/division of its renal vessels is still a main concern. Here, we describe a simple-to-perform technique, i.e., flipping the fully mobilized right kidney to the midline so that the renal artery becomes anteriorly, which offers better visualization and easier dissection of the renal vessels (achieving maximized lengths) when performing hand-assisted LLDN of the right kidney.

Methods: Living donors who underwent hand-assisted LLDN of the right kidney, along with their respective renal transplant recipients, were included in this report. Donor characteristics included renal artery and vein lengths; recipient characteristics included creatinine at months 12 – 36. Graft vein and arterial anastomosis data were also reported.

Results: Nineteen living donors and 19 recipients, with median donor and recipient ages being 39 (24 – 60) and 53 (3 – 81) years, respectively, were included. None of the 38 patients had intra- or postoperative complications. Donor renal vein was anastomosed to the right external iliac vein (n = 16), right common iliac vein (n = 2), and inferior vena cava (n = 1). Gonadal vein (n = 1) and deceased donor iliac vein (n = 2) were used to increase the right renal vein length in 3 cases. Four donor kidneys had 2 arteries reconstructed side by side. None of the recipients developed any vascular or urological complications.

Conclusions: The laparoscopic technique described is safe and allows better visualization of the right hilum, mainly the renal artery, and helps in stapling the renal vein and renal artery.

Key Words: Nephrectomy, Living donor, Laparoscopic, Renal artery, Recipients.

Department of Surgery, Miami Transplant Institute, University of Miami Miller School of Medicine, Jackson Memorial Hospital, Miami, FL (Drs. Ciancio, Farag, Gaynor, Morsi, Chen, Burke III).

Department of Urology, University of Miami Miller School of Medicine, Jackson Memorial Hospital, Miami, FL (Dr. Ciancio).

Department of Surgery, Zagazig University School of Medicine, Zagazig, Egypt (Dr. Farag).

Disclosure: none.

Funding sources: none.

Conflict of interests: none.

Informed consent: Dr. Gaetano Ciancio declares that written informed consent was obtained from the patient/s for publication of this study/report and any accompanying images.

Address correspondence to: Dr. Gaetano Ciancio, MD, University of Miami Miller School of Medicine Department of Surgery and Urology, 1801 NW 9th Ave, 7th Floor Miami, FL, 33136. Tel: +1 305 355-5803, E-mail: gciancio@med.miami.edu.

DOI: 10.4293/JSLS.2021.00018

INTRODUCTION

Laparoscopic living donor nephrectomy is the surgical procedure most used to recover the living donor kidney.[1] Transplant surgeons prefer to remove the left donor kidney for transplantation, as the anatomy of the right donor kidney does not lend itself for easy removal, particularly as the likelihood of a short renal vein existing on the right side is much greater, increasing both the risk of injury to the donor's inferior vena cava (IVC) as well as the risk of renal vein thrombosis occurring in the transplant recipient.[2] In addition, on the right side there is greater variability in the length of the renal artery (which increases the likelihood that the right renal artery is also short), mobilization of the right lobe of the liver is required for kidney removal,[3] and there also exists a greater likelihood of encountering multiple renal arteries.[4]

The dissection and stapling of the right renal hilum is therefore a critical step during laparoscopic nephrectomy of the right donor kidney. Multiple maneuvers and surgical approaches for ligation of vessels have been developed to best handle the right renal hilum, including those for the right renal vein (RRV),[5–8] the right renal artery (RRA)[9,10], and both renal vessels.[11]

We describe a midline rotating maneuver of the right donor kidney that provides better visualization and easier dissection of the renal hilum, making stapling of the renal vessels easier to perform and maximizing the RRA and RRV lengths. Clinical outcomes among the transplant recipients who received these right living donor kidneys (with multiple arteries and vein reconstruction) are also included in this report.

MATERIALS AND METHODS

This study was reviewed and approved by the Institutional Review Board and abides by the Helsinki Declaration (as revised in 2013). Written informed consent was obtained from each of the study participants. Donor renal vascular anatomy was evaluated by a computed tomography (CT) angiography with 3D reconstruction.

Nineteen patients undergoing hand-assisted laparoscopic living donor nephrectomy (LLDN) of the right kidney between February 1, 2012 and May 31, 2017 were identified, and a retrospective chart review was performed to evaluate both the donor and recipient outcomes. Reasons for using the right donor kidney in these 19 cases included: the presence of cyst(s), aneurysm(s), or kidney stones in the right donor kidney (N = 10), the presence of multiple renal arteries in the left kidney (N = 5), and knowledge that the donor's right kidney was distinctly smaller in comparison with the left kidney (N = 4). The donor's right kidney was always chosen for transplantation when it was considered to be the less favorable kidney to use (in comparison with the left kidney).

Operative Technique

After general anesthesia induction, the living donor patient was positioned, at 30°, in the left lateral decubitus position. The patient was placed on a beanbag and given adequate padding. After performing a periumbilical incision, a GelPort (Applied Medical, Rancho Santa Margarita, CA) using a 10 mm trocar was placed within the midline incision, creating a pneumoperitoneum of 12 – 15 mmHg pressure. Under direct visualization, one 5-mm port (working port) was placed in the midaxillary line 3 – 5 cm subcostal but more caudal than on the left.[12] A second 5-mm port (camera port) was placed at the middle of the line joining the GelPort and right iliac crest (**Figure 1**). The left hand was used to retract the liver superiorly when it was needed, along with medial mobilization of the right colon and duodenum. Thereafter, the right kidney was fully mobilized. The RRV was dissected from the takeoff of the IVC. In one case, the right gonadal vein was dissected along with the ureter and used for renal vein reconstruction.

The RRA was dissected; and to obtain enough length, the fully mobilized right kidney was flipped to the midline so that the renal artery became anteriorly (**Figure 2A**). This maneuver allows for easier dissection of both the RRA and RRV, maximizing the length of each vessel as well as creating better visualization of the posterior space between the RRA and RRV-IVC (**Figure 2B**). After careful dissection of the RRA and RRV, the renal artery or arteries were stapled using the Echelon Flex™ powered vascular stapler with 45-mm staples. Once the renal artery or arteries were stapled, the RRV was better visualized (**Figure 2C**). The right kidney is usually held up with the surgeon's hand, allowing some traction of the RRV, and the stapling device was placed as close to the IVC as possible. After stapling the ureter and both right renal vessels, the kidney was manually extracted through the GelPort and placed on ice-slush. We do not see the need to divide lumbar veins on the posterior aspect of the IVC,[9] and none of the 19 donor right kidneys removed in this study had any vessels posterior to the RRV.[9]

Following hand-assisted laparoscopic extraction of the donor kidney, standard benching preparation was performed, and the graft was flushed with cold Histidine-tryptophan-ketoglutarate solution until the effluent was clear. The renal arteries and veins were dissected from the surrounding perivascular lymphatics and fat, and the small side branches were ligated. The ureter with its blood supply and the periureteric tissue were preserved, and all remaining redundant perinephric fat was trimmed. The graft renal vein and artery were anastomosed to the iliac veins or IVC, and to the iliac arteries or aorta, respectively. Ten of the transplant recipients required mobilization of the external iliac vein with ligation of the internal iliac veins, which allowed the avoidance of performing reconstructive surgery in these cases.

Once reperfusion of the graft was achieved, mobilization of the bladder with subsequent modified extravesical ureteroneocystostomy[13] was carried out using two running 6-0 polydioxanone sutures. Finally, the detrusor muscle was closed over the anastomosis to create an antireflux tunnel with interrupted 4-0 polydioxanone suture.

RESULTS

A total of 19 living donor patients (9 males and 10 females) were included in this study. All underwent hand-

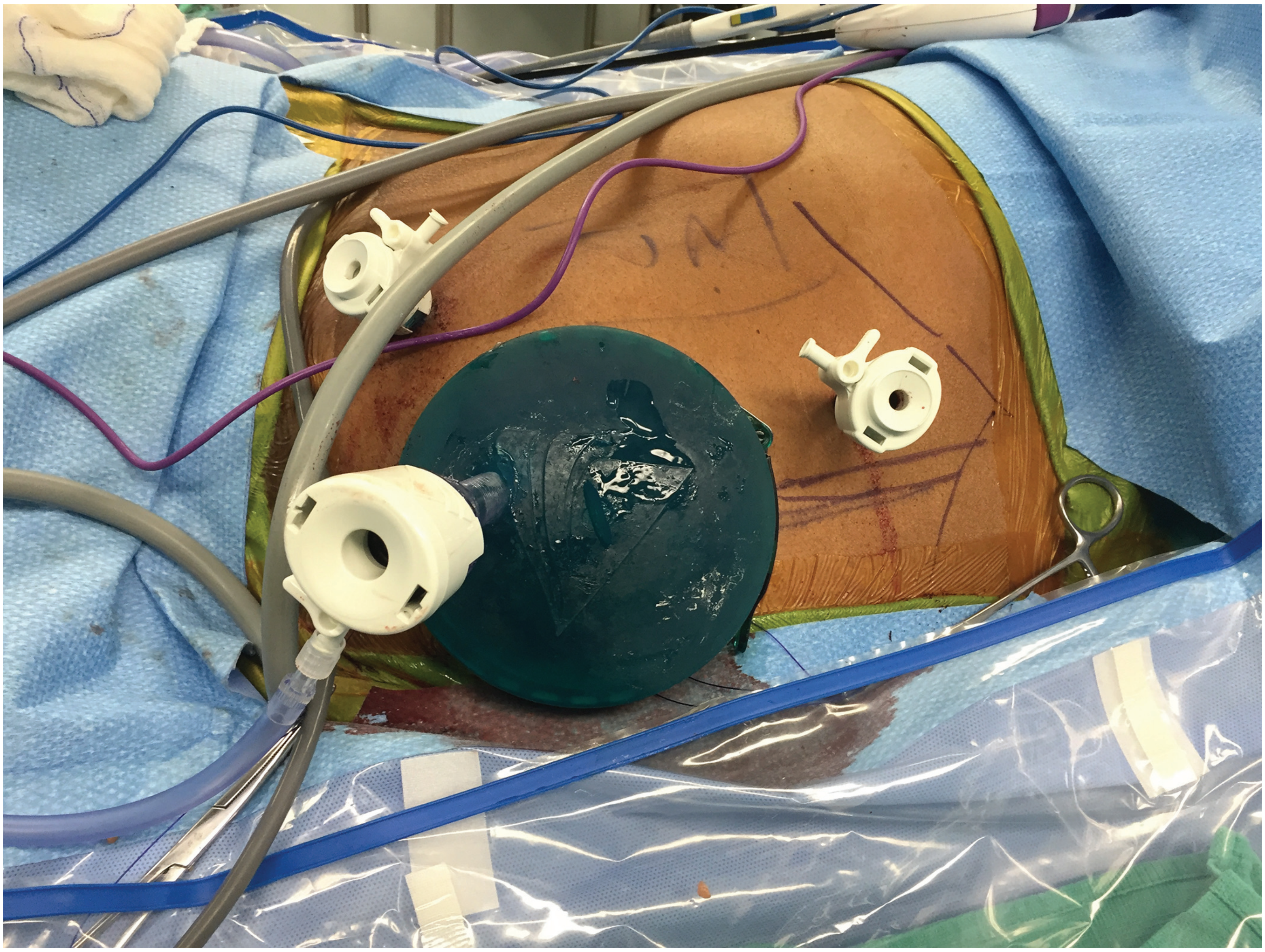

Figure 1. Patient positioned on left lateral positioned at 30 degrees. The GelPort is placed in midline with a 10-mm trocar. The other two 5-mm ports are in place.

assisted LLDN of the right kidney. Median donor age was 39 (range: 24 – 60) years, and median donor body mass index (BMI) was 28.1 (range: 19.9 – 33.5) kg/m^2. Donor intraoperative blood loss was minimal, and median warm ischemia time (WIT) was 1 (range: 1 – 2) minute(s). Median RRA and RRV lengths were 40.0 (range: 30.0 – 60.0) cm and 30.0 (range: 10.5 – 50.0) cm, respectively. Lengths of RRV for the 19 transplanted cases were as follows: 10.5 cm (n = 1), 2 cm (n = 4), 2.5 cm (n = 3), 3 cm (n = 8), 4 cm (n = 1), and 5 cm (n = 2). Four donors had 2 right renal arteries. None of the donors in this study required conversion or re-operation. The donor kidneys were transplanted into 19 recipients (14 males and 5 females). Median recipient age was 53 (range: 3 – 81) years, with one recipient being a child. Median recipient BMI was 25.5 (range: 18.3 – 38.3) kg/m^2. Median estimated blood loss among the 19 recipients was 100 (range: 20 – 300) ml, and median recipient WIT was 39 (range: 25 – 60) minutes. Distributions of selected donor and recipient characteristics are shown in **Table 1**.

The right donor renal vein was anastomosed to the: (1) recipient right external iliac vein, after complete mobilization and ligation of all internal iliac veins, in 10 patients; (2) recipient right external iliac vein (without performing a complete mobilization) in 6 patients, although 3 of these patients required reconstruction of the RRV (using the donor gonadal vein in 1 case and deceased donor external iliac veins in 2 cases); (3) common iliac vein in 2 recipients; and (4) IVC in 1 pediatric recipient. Of note, the RRV length in the 3 cases who required RRV reconstruction was particularly short (1.5, 2, and 2 cm, respectively).

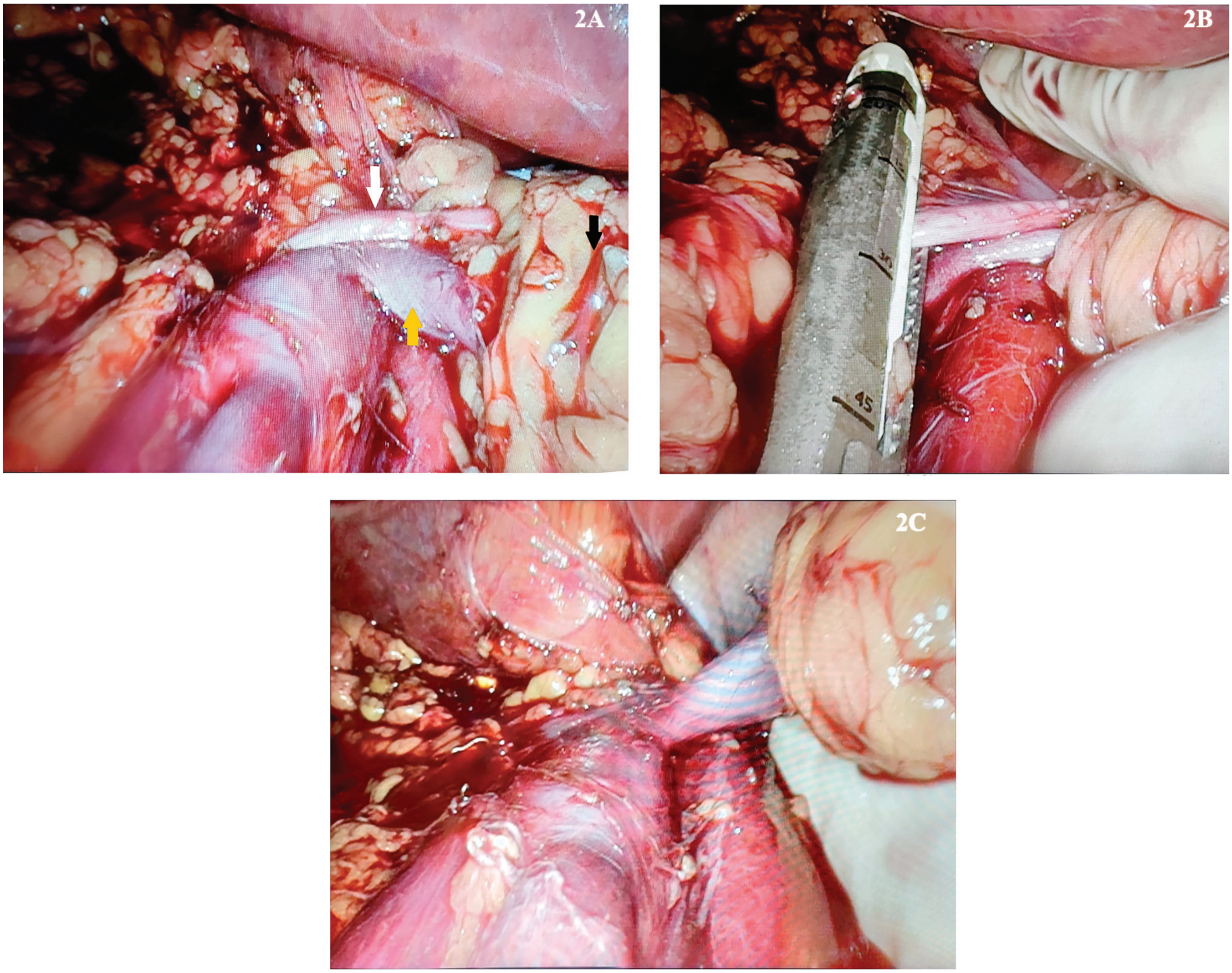

Figure 2. (**A**) Showing the right kidney rotated medially. (Black Arrow: Right kidney, Yellow Arrow: Right renal vein, White Arrow: Right renal artery). (**B**) Stapling the right renal artery on the back of the cava. (**C**) The right kidney is held up with some traction of the right renal vein.

The donor renal artery was anastomosed to the right external iliac artery, except in pediatric recipients where it was anastomosed to the aorta (n = 1) (in an end to side fashion in all cases). Four donors with 2 arteries required double-barrel side to side vascular reconstruction with 7-0 Prolene sutures. Three renal artery aneurysms were repaired with 7-0 Prolene sutures, with one donor having one renal aneurysm and another donor having 2 aneurysms, respectively.

One right donor kidney required 2 partial nephrectomies for removal of 2 complex cysts. The final pathology was benign for both cysts.

None of the recipients experienced delayed graft function. There were no vascular or urological complications that occurred during or after the surgery.

DISCUSSION

Living donor nephrectomy has expanded the renal donor pool, allowing an increased number of renal transplants to be performed annually. While LLDN has become the standard of care for living donor nephrectomy, LLDN of the right kidney is performed less often in comparison with the left kidney.[12] Abrahams et al.[14] reported that two of the most common indications for selecting a right kidney for

Table 1.
Distributions (Medians and Ranges) of Selected Donor and Recipient Characteristics

Donors (n)	19
Operative time (min)	90 (60–150)
Warm ischemia time (min)	1 (1–2)
Postoperative length of stay (days)	3 (2–3)
Serum creatinine at 12 months (mg/dl)	1.1 (1.0–1.5)
Recipients (n)	19
Reconstruction of the Right Renal Vein	3/19
Donor Gonadal Vein	1/19
Deceased Donor Iliac Veins	2/19
Reconstruction of the RRA	6/19
Aneurysm Resection x 3, one donor had 2 aneurysms (n)	2/19
Double-barrel side to side of 2 RRA reconstruction (n)	4/19
Warm ischemia time (min)	39 (25–60)
Estimated blood loss (ml)	100 (20–300)
Incidence of DGF (n)	0/19
Serum Creatinine (mg/ml)	
At 12 months	1.2 (0.6–1.9)
At 24 months	1.2 (0.6–2.0)
At 36 months	1.2 (0.7–1.7)

DGF, delayed graft function; RRA, right renal artery.

donation include the presence of multiple left renal arteries and nephrolithiasis in the right kidney.

LLDN of either side is a difficult procedure to perform on a healthy individual. For many transplant surgeons, performing an LLDN of the right kidney can be even more demanding and complex.[15] However, in certain respects, a hand-assisted LLDN of the right kidney may be easier to perform due to the absence of gonadal, adrenal, and lumbar vessels. Also, performing a right donor nephrectomy would not be associated with any risk of occurrence of splenic injuries.[16]

In contrast, we think that hand-assisted LLDN of the right kidney is complicated due to the presence of the IVC, a short renal vein and the fact that the renal artery lies behind a short renal vein. Therefore, the RRA length could be compromised in addition to having to manage a short RRV.

Different techniques and devices have been developed for controlling the renal hilum, mainly the short RRV, during a right-sided LLDN. One of these techniques is a modified right LLDN using an endo-Satinsky clamp and in-situ cold perfusion of the kidney[7] or a hybrid approach using a regular Satinsky clamp.17,[18] Each of these techniques have been reported as safe to perform and extended the length of the donor RRV, but only one study reported the length of the renal vein in comparison with the standard laparoscopic technique.[7]

Simforoosh at al[19] reported 32 renal transplant recipients who received a right kidney with a short renal vein ligated by clipping the vein during right LLDN. They placed the kidney graft upside-down in the recipient's right iliac fossa to overcome the problem of the short renal vein. There was no vascular thrombosis observed during or after the transplant surgery.[19] Despite the authors' good results, we believe that this transplant technique is not the answer for a short renal vein.

More recently, Liu at el[5] compared the use of staplers versus clips for renal pedicle ligation in LLDN. In their conclusion, using clips for right-sided LLDN increased the vessels' lengths and have potential economic advantages.[5] We use a stapler for ligation of the right renal hilum which securely transfixes the vessels wall.

Knowing all of the obstacles in performing a hand-assisted LLDN of the right kidney, we use a modified maneuver[9] in that once the right kidney is completely mobilized, it is flipped medially, making the RRA become anteriorly, and the dissection and stapling of both vessels becoming easier to perform. Once the right kidney is mobilized to the midline, the RRA becomes anteriorly, and the staple device can be moved slightly along the posterior wall of the IVC, increasing the length of the RRA. Once the renal artery is stapled, the hand of the surgeon can hold up the kidney with some traction, and the RRV is then stapled. We believe that there is no need to divide lumbar veins posterior to the IVC and renal vein.[9]

In this series using our technique, 16 recipients had the RRV anastomosed to the right external iliac vein, 2 to the right common iliac vein, and 1 (a pediatric case) to the IVC. Three recipients with a very short RRV had it reconstructed; one using the living donor's gonadal vein, and 2 using a deceased donor iliac vein. The RRA was long enough in each case, with none of the recipients requiring reconstruction. Four donors had 2 right kidney arteries, and a double-barrel side to side vascular reconstruction was performed with 7-0 Prolene. None of the recipients developed any vascular or urological complications.

One study limitation is the fact that the results reported here were not based on a randomized controlled study, nor was there an available historical control group of transplanted recipients at our center who received a right living donor kidney via hand-assisted LLDN but without using a midline rotation prior to dissection of the renal vessels. However, none of the 38 study participants (19 donors and 19 recipients) developed any intra- or postoperative (including vascular or urological) complications, and the requirement for reconstructive surgery of the RRV was minimized, demonstrating the potential advantages in using this midline rotation surgical technique.

CONCLUSION

Despite a small number of cases, this midline rotating maneuver is simple to perform and facilitates easier dissection and ligation of the renal hilum during hand-assisted LLDN of the right kidney.

References:

1. Khalil A, Mujtaba MA, Taber TE, et al. Trends and outcomes in right vs. left living donor nephrectomy: an analysis of the OPTN/UNOS database of donor and recipient outcomes–should we be doing more right-sided nephrectomies? *Clin Transplant.* 2016;30(2):145–153.

2. Lind MY, Hazebroek EJ, Hop WCJ, et al. Right-sided laparoscopic live-donor nephrectomy: is reluctance still justified? *Transplantation.* 2002;74(7):1045–1048.

3. Posselt AM, Mahanty H, Kang SM, et al. Laparoscopic right donor nephrectomy: a large single-center experience. *Transplantation.* 2004;78(11):1665–1669.

4. Broudeur L, Karam G, Chelghaf I, et al. Feasibility and safety of laparoscopic living donor nephrectomy in case of right kidney and multiple-renal artery kidney: a systematic review of the literature. *World J Urol.* 2020;38(4):919–927.

5. Liu Y, Huang Z, Chen Y, et al. Staplers or clips?: a systematic review and meta-analysis of vessel controlling devices for renal pedicle ligation in laparoscopic live donor nephrectomy. *Medicine (Baltimore).* 2018;97(45):e13116.

6. Kaushik M, Bagul A, Yates PJ, et al. Comparison of techniques of vascular control in laparoscopic donor nephrectomy: the Leicester experience. *Transplant Proc.* 2006;38(10):3406–3408.

7. Zhong X, Huang C, Li L, et al. Endo-Satinsky clamp hybrid in situ perfusion in retroperitoneoscopic donor nephrectomy for right-sided kidney. *Urology.* 2019;130:191–195.

8. Meng MV, Freise CE, Kang SM, et al. Techniques to optimize vascular control during laparoscopic donor nephrectomy. *Urology.* 2003;61(1):93–98.

9. Buell JF, Hanaway MJ, Woodle ES. Maximizing renal artery length in right laparoscopic donor nephrectomy by retrocaval exposure of the aortorenal junction. *Transplantation.* 2003;75(1):83–85.

10. Chow GK, Chan DY, Ratner LE, Kavoussi LR. Interaortocaval renal artery dissection for right laparoscopic donor nephrectomy. *Transplantation.* 2001;72(8):1458–1460.

11. Sozener U. Single stapler technique for vascular control in laparoscopic donor nephrectomy. *Transplant Proc.* 2020Sep 11; S0041-1345(20)32689-0. Online ahead of print.

12. Shirodkar SP, Sageshima J, Bird VG, et al. Living donor nephrectomy: University of Miami technique and current results. *Arch Esp Urol.* 2010;63:163–170.

13. Ciancio G, Farag A, Gonzalez J, et al. Results of a previously unreported extravesical ureteroneocystostomy technique without ureteral stenting in 500 consecutive kidney transplant recipients. *PLoS One.* 2021;16(1):e0244248.

14. Abrahams HM, Freise CE, Kang SM, et al. Technique, indications and outcomes of pure laparoscopic right donor nephrectomy. *J Urol.* 2004;171:793–796.

15. Wang K, Zhang P, Xu X, Fan M. Right versus left laparoscopic living-donor nephrectomy: a meta-analysis. *Exp Clin Transplant.* 2015;13(3):214–216.

16. Rally S, Sharma A, Singh S, et al. Experience with 15 years of laparoscopic donor nephrectomy: review of 2500 cases. *Transplant Proc.* 2020;52(6):1671–1674.

17. Margreiter C, Gummerer M, Gallotta V, et al. Open management of the renal vein is a safe modification in right-sided laparoscopic living donor nephrectomy to maximize graft vein length. *Transplant Proc*. 2018;50(10):3199–3203.

18. Kim BS, Kim KH, Yoo ES, Kwon TG. Hybrid technique using a Satinsky clamp for right-sided transperitoneal hand-assisted laparoscopic donor nephrectomy: comparison with left-sided standard hand-assisted laparoscopic technique. *Urology*. 2014;-84(6):1529–1534.

19. Simforoosh N, Aminsharifi A, Tabibi A, et al. Right laparoscopic donor nephrectomy and the use of inverted kidney transplantation: an alternative technique. *BJU Int*. 2007;100(6):1347–1350.