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ORIGINAL ARTICLE

Feasibility and safety of laparoscopic living donor nephrectomy in case of right kidney and multiple-renal artery kidney: a systematic review of the literature

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Abstract

Purpose To access the current status of the security and feasibility of right kidney (RK) and multiple-renal artery (MRA) laparoscopic living donor nephrectomy (LLDN) which are more challenging compared to left kidney (LK) and single renal artery (SRA) because of a shorter renal vein and more complex vascular anatomy.

Methods We did a systematic review of the literature according to the PRISMA recommendations, reporting RK or MRA donor nephrectomy performed with a laparoscopic technique compared to LK or SRA kidney LLDN. The identified and analyzed primary outcomes of interest were operating time (OT), warm ischemia time (WIT), rate of conversion and transfusion, donor length of stay (LOS), delayed graft function (DGF) and rate of graft loss (GL).

Results 16 comparative studies (1397 cases) of RK-LLDN and 12 comparative studies including 15 series (993 cases) of MRA-LLDN were selected. For RK-LLDN review, conversion rate was 0.8% and blood transfusion rate 0.2%, only one case of graft venous thrombosis was reported, OT was shorter in four studies and there was no any difference of DGF and GL rate compared to LK-LLDN. For MRA-LLDN review, conversion rate was 1.3% and blood transfusion rate 1.1%, OT and WIT were longer compared to SRA-LLDN, there were more ureteral complications in two studies, and no difference in terms of vascular complications and graft loss rate.

Conclusion RK-LLDN and MRA-LLDN would be similar to LK-LLDN and SRA-LLDN in terms of feasibility and safety for the donor as well as graft function results for RK-LLDN.

Keywords Living donor nephrectomy · Laparoscopic donor nephrectomy · Hand-assisted laparoscopic donor nephrectomy · Right kidney · Multiple renal arteries

Abbreviations

LLDN	Laparoscopic living donor nephrectomy
RK	Right kidney
MRA	Multiple renal artery
LK	Left kidney
SRA	Single renal artery
OT	Operating time
WIT	Warm ischemia time
LOS	Length of stay
DGF	Delayed graft function
GL	Graft loss

Introduction

Since the first laparoscopic living donor nephrectomy (LLDN) performed by Ratner in 1995 [1], laparoscopic procedures have been shown to be superior with lower donor morbidity compared to open surgery [2, 3]. They are mostly performed for living kidney donation. The commonly approved approach is to ensure maximum safety for the donor during kidney sampling and during the short-term post-operative course by selecting the kidney with the easier anatomy, which is why a single renal artery left kidney is preferred due to the longer renal vein, which also facilitates

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implantation. However, it is also important to consider the donor's long-term safety by leaving the kidney with the better function [4]. These two priorities sometime require right kidney and/or multiple-renal artery kidney nephrectomy, which is considered to be technically more challenging: the shorter right renal vein has been associated with renal vein thrombosis [5] and inferior vena cava bleeding during nephrectomy [6]; multiple-renal artery kidney has been associated with a higher rate of vascular and ureteral complications [7]. The objective of this review is to evaluate the feasibility, safety and efficacy of right and multiple-renal artery LLDN compared to left kidney and single-renal artery LLDN.

Materials and methods

The systematic review strategy was conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-analysis (PRISMA) [7].

Literature search strategy

A literature search was performed in March 2019 for studies published between 1995 (since the first LLDN [1]) and 2019 without restriction to regions. Only English language publications were considered. Medline (PubMed), ScienceDirect and Cochrane Library databases were searched. For the "right kidney" (RK) systematic review, the following terms and strategy were used: living donor AND nephrectomy AND right AND (kidney OR transplant OR graft OR side), and for the "multiple renal arteries" (MRA) systematic review: living donor AND nephrectomy AND multiple AND (arteries OR vessels). The identification, detection and inclusion of studies were realized by one author and the extraction of outcomes of interest was realized independently by two co-authors. Conflicts between investigators about the outcomes of interest were reviewed and agreements were reached on the final interpretation of the data.

Inclusion criteria

All available studies included were randomized controlled trials, prospective or retrospective comparative studies: RK-LLDN versus left kidney (LK) LLDN or MRA-LLDN versus single-renal artery kidney (SRA) LLDN. Only trials performed with a laparoscopic technique were considered including: pure laparoscopic trans- or retroperitoneal procedure, hand-assisted trans- or retroperitoneal laparoscopic procedure, robot-assisted laparoscopic procedure, laparoscopic procedure with a mini-open approach only for the vessel ligature and graft extraction. When multiple trials were from the same authors and/or institute, only the latest publication was included.

Exclusion criteria

Studies were excluded for the following reasons: sample size < 20, case of open nephrectomy procedure included in laparoscopic procedure results, case of LK-LLDN procedure mixed in RK-LLDN series results for RK-LLDN review, case of SRA-LLDN procedure mixed in MRA-LLDN series results for MRA-LLDN review, and missing primary outcomes > 3. Non-comparative studies, case reports, and review articles were excluded. The systematic review search strategy and result are detailed on Fig. 1 for both reviews.

Outcomes of interest

The primary outcomes of interest assessing feasibility and security of LLDN for the donor were: operative time (OT), warm ischemia time (WIT), conversion rate, donor blood transfusion rate and length of hospital stay (LOS). The primary outcomes to determine graft function after LLDN were delayed graft function (DGF) and graft loss (GL). For the RK-LLDN review, the secondary outcomes collected was the vascular thrombosis rate to evaluate the specific complications of RK transplants and for the MRA-LLDN review, the secondary outcomes of interest were the arterial and ureteral complication rates to evaluate specific MRA transplant complications. Qualitative independent data were compared using a Chi square test or a Fisher exact test according to the validity conditions.

Results

Right kidney laparoscopic living donor nephrectomy

Sixteen studies [8–23] including 1397 cases met the inclusion criteria and are summarized in Table 1. These studies included one randomized controlled trial [12], three prospective comparative studies [9, 15, 16] and 12 retrospective comparative studies [8, 10, 11, 13, 14, 17–23].

Surgical and donor outcomes

The surgical procedure consisted of pure transperitoneal laparoscopy in five trials [8, 10, 13, 15, 17], pure retroperitoneal laparoscopy in two trials [11, 21] hand-assisted transperitoneal laparoscopy in four series [9, 12, 16, 19], hand-assisted retroperitoneal laparoscopy in one study [20], laparoscopic procedure with a mini-open incision only for the vessel ligature and graft extraction in two studies [18, 22] and a

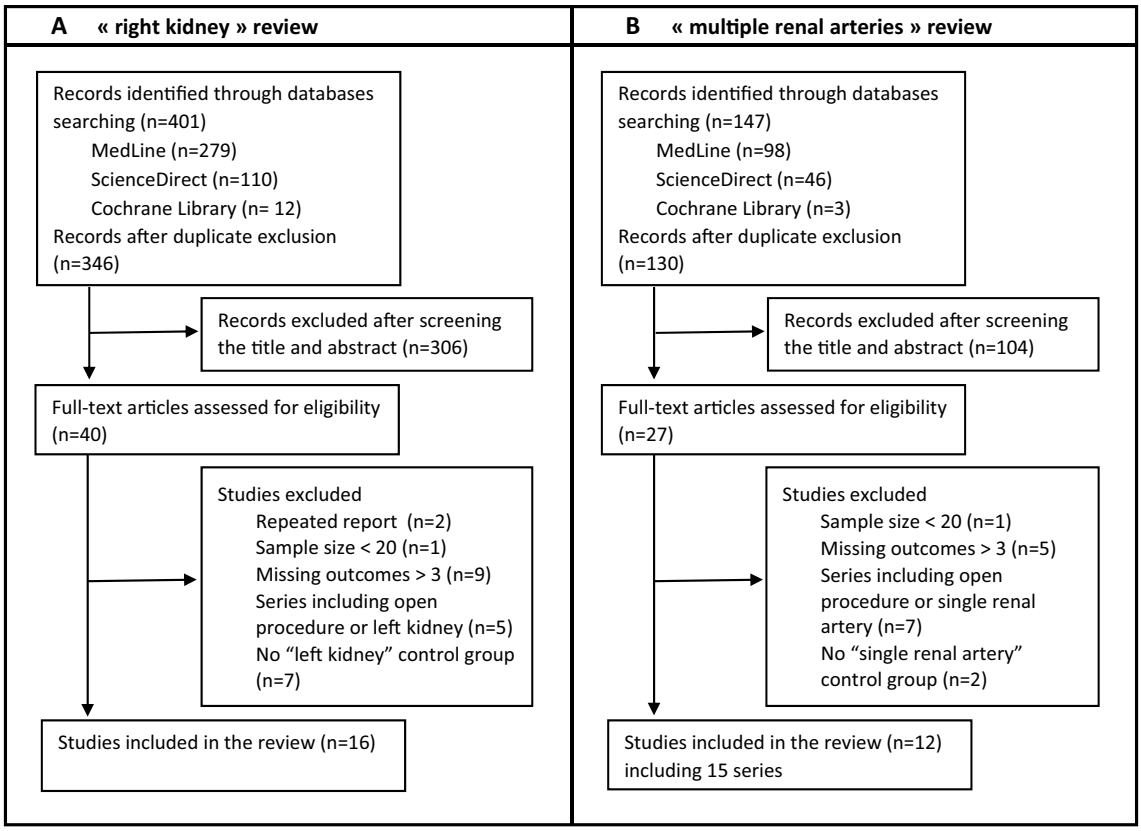

Fig. 1 Flow diagrams outlining the study selection process

combination of two techniques in two series [14, 23]. To secure the renal vein ligature and transection, an endoscopic stapler was used in 12 trials (7 with vascular Endo-TA [8, 10, 11, 16, 17, 20, 23], 3 with vascular Endo-GIA [13, 15, 19], 2 not specified [9, 12]), Hem-o-lock clip in two studies [21, 23], and a running prolene suture after placing a Satinsky clamp on the inferior vena cava in 2 trials [18, 22]. Mean OT ranged from 101 to 224 min. One study [19] only reported pneumoperitoneum time and were, therefore, not considered. Mean WIT ranged from 0.7 to 5.6 min. Compared to LK-LLDN, four studies [8, 15, 20, 23] reported a significantly shorter OT and one [21] a longer OT, and three studies [14, 21, 22] reported a significantly longer WIT. Only 11 (0.8%) conversions to open surgery were reported in all of the series selected: five for vascular injuries (inferior vena cava, renal artery, inferior polar artery and renal vein × 2), three for complex renal vessels, one for massive peritoneal adhesions and two undefined. Qiu [21] reported significantly more cases of conversion to open surgery in RK-LLDN compared to LK-LLDN (1.9% vs 0.2%, $p = 0.041$), but in the overall of this review there is no significant difference in conversion rate compared to LK-LLDN (0.8% (11/1397) vs 0.5% (22/4182), $p = 0.270$). Overall, in these published studies, there were 2 blood transfusions (0.2%) post-operatively in RK-LLDN and 12 (0.6%) in LK-LLDN ($p = 0.25$). Dols [15] also reported significantly fewer intra-operative complications for RK-LLDN. Mean LOS ranged from 2.4 and 10.4 days with no significant difference compared to LK-LLDN except for Ruszat [11] who reported a shorter LOS in favour on RK-LLDN (5.9 vs 7.3 days, $p = 0.03$).

Recipient and graft function outcomes

The recipient DGF rate, defined as the need for dialysis during the first post-operative week, ranged between 0 and 11.1% according to the various studies. Gures [17], Diner [10] and Song [19] reported 1.5%, 0% and 0% of DGF, respectively, but DGF was not defined. No studies in this review demonstrated any significant difference in terms of DGF compared to LK-LLDN as in the overall of the review (1.8% (16/889) vs 2.0% (38/1932), $p = 0.76$). Only five cases of graft vascular thrombosis were reported in RK-LLDN; there were two arterial thrombosis in both Dols [15] and Kashiwadate [20] trials and one venous thrombosis cause of graft loss in Maartense [9] study. There is no significant difference in terms of vascular thrombosis rate in RK-LLDN compared to LK-LLDN with 0.4% (5/1174) and 0.2% (6/3042), respectively ($p = 0.19$). The 1-year GL rate ranged

Table 1 Studies included in the systematic review of right kidney living donor nephrectomy

Authors	Country	Years	Sample size	OT (min)	WIT (min)	Conversion	Blood transfusion	LOS (days)	DGF	Vascular thrombosis	Graft loss (1 year/long term)	
Posselt [8]	USA	2004	54	169	4.5	0 (0%)	0 (0%)	3.2	3 (5.6%)	0 (0%)	–	–
Maartense [9]	Netherlands	2004	23	140[a]	2.5[a]	0 (0%)	0 (0%)	5.0[a]	–	1 (4.3%)	2 (8.7%)	–
Diner [10]	USA	2006	40	220	5.3	0 (0%)	0 (0%)	2.4	0 (0%)	0 (0%)	–	–
Ruszat [11]	Switzerland	2007	28	142	2.0	1 (3.6%)	0 (0%)	5.9	–	–	–	–
Minnee [12]	Netherlands	2008	31	150[a]	3.0[a]	0 (0%)	0 (0%)	4.0[a]	1 (3.2%)	0 (0%)	2 (6.4%)	–
Saad [13]	Germany	2008	25	160[a]	2.5[a]	1 (4%)	0 (0%)	7.0[a]	–	0 (0%)	–	–
Keller [14]	USA	2009	36	177	1.5	–	0 (0%)	3.6	4 (11.1%)	0 (0%)	–	1 (2.8%)
Dols [15]	Netherlands	2009	159	202	5.6	2 (1.3%)	–	3.3	–	2 (1.3%)	2 (1.3%)	6 (3.8%)
Hoda [16]	Germany	2010	51	123	0.7	0 (0%)	0 (0.0%)	3.4	1 (2.0%)	0 (0%)	1 (2.0%)	–
Gures [17]	Turkey	2013	65	144	2.5	0 (0%)	–	2.4	1 (1.5%)	0 (0%)	1 (1.5%)	–
Kim [18]	Korea	2014	51	224	3.3	1 (2.0%)	–	4.9	–	–	1 (2.0%)	–
Song [19]	Korea	2015	421	90	2.5	0 (0%)	1 (0.2%)	5.2	0 (0%)	0 (0%)	–	16 (3.8%)
Kashiwadate [20]	Japan	2015	87	175	4.6	1 (1.1%)	–	10.4	4 (4.6%)	2 (2.3%)	1 (1.1%)	–
Qiu [21]	China	2017	104	101	4.1	2 (1.9%)	1 (0.9%)	–	2 (1.9%)	–	–	–
Margreiter [22]	Austria	2018	54	199	2.3	0 (0.0%)	–	8.2	–	0 (0.0%)	0 (0.0%)	12 (22.2%)
Kumar [23]	India	2018	168	120	4.8	3 (1.8%)	–	4.2	–	0 (0.0%)	–	–

OT operating time, *WIT* warm ischemia time, *LOS* length of stay, *DGF* delayed graft function

[a]Continuous variables expressed as median

from 0 to 8.7% among the eight studies reporting these outcomes. The causes of early GL were: humoral rejection (2), arterial thrombosis (2), venous thrombosis (1), primary non-function (1), not defined (4). The studies reporting GL rate after more than 1 year were defined as long-term GL rate and the higher rate was 22.2% after 5-year follow-up. No significant differences in terms of 1-year and long-term GL rates were observed between RK and LK-LLDN in all the comparative studies.

Multiple-renal artery kidney laparoscopic living donor nephrectomy

Twelve studies [14, 24–29, 34] including 15 series comprising a total of 993 cases were selected for the final analysis and are presented in Table 2. Three trials included two series each: Desai [27] reported a series with two renal arteries and another with an early branching renal artery resulting of two anastomosis, and both Cooper [32] and Omoto [33] reported two series, one comprising kidneys with two renal arteries and the other comprising kidneys with three or more renal arteries. All studies were retrospective comparative series versus SRA-LLDN.

Surgical and donor outcomes

The surgical procedure consisted of standard laparoscopy in five trials [24–27, 29], hand-assisted transperitoneal laparoscopy in two studies [28, 30], retroperitoneal laparoscopy in one study [33], and mixed techniques (standard laparoscopy and hand-assisted laparoscopy) in four studies [14, 31, 32, 34]. Mean OT ranged between 114 and 365 min, and was significantly longer in seven series [27–30, 33, 34]. In the study reported by Omoto [33], the OT was significantly longer (365 min) for kidneys with three or more renal arteries compared to SRA-LLDN, but not for kidneys with two renal arteries. WIT ranged from 1 to 6 min and was significantly longer in eight series [14, 27, 30–33]. Overall, in these published series, there were 1.3% (12/922) conversions to open surgery and 1.1% (4/350) blood transfusions, and these rates were not significantly different compared to LK-LLDN with 1.0% (34/3487, $p=0.37$) and 0.8% (11/1398, $p=0.51$), respectively. Cooper [32] reported seven conversions, mainly due to vascular injuries, Oh [24] reported two due to vascular injury and endostapler malfunction, Carter [26] reported one due to bowel injury, Paragi [29] reported one for uncontrolled haemorrhage, and Meyer [31] reported one conversion due to renal vein injury. Mean LOS ranged between 3.8 and 4.9 days. No significant difference was observed compared to SRA-LLDN except Omoto [33] who report a significant longer LOS in the three or more renal arteries group compared to two renal arteries group and SRA group (4.9 vs 3.8 and 3.7 days, respectively).

Recipient and graft function outcomes

The recipients DGF rate ranged between 0 and 11.6%. In two studies [28, 33], reporting DGF rates of 0% and 8.3%, respectively, DGF was not defined. In the other studies, DGF was defined as the need for dialysis during the first post-operative week. Cooper reported the highest DGF rate (11.6%) in a series comprising kidneys with three or more renal arteries, which was significantly higher than for kidneys with two renal arteries and SRA (4.8% and 5.1%, respectively). A total of 9 (2.2%) arterial complications were reported: 3 thrombosis, 3 stenoses, 1 pseudoaneurysm at the site of an anastomosis and 2 undefined; and 42 (4.4%) ureteral complications (leak, stricture or necrosis) were reported. No significant difference in terms of arterial complications was observed, but in two studies [26, 32], the authors reported more ureteral complications for MRA-LLDN. Cooper [32] also reported a significant difference with a higher ureteral complication rate in the series of kidneys with three or more renal arteries compared to kidneys with two renal arteries. Overall, in the whole review, there is no significant difference in terms of arterial complications compared to SRA-LLDN (2.2% (9/413) vs 1.3% (21/1606), $p=015$), but there is a significant difference in terms of ureteral complications (4.4% (42/950) vs 2.6% (91/3472), $p=0.004$) and DGF (4.4% (29/666) vs 3.6% (88/2425), $p=0.006$) in favour of SRA-LLDN. The 1-year GL rate ranged from 0 to 13.2% and the long-term GL rate ranged from 4.5 to 26.7%. Paragi [29] reported a significantly higher 1-year GL (6.5% vs 1.5%) and Paramesh [28] a significantly higher long-term GL after 5-year follow-up (26.7% vs 14%) compared to SRA-LLDN, while no significant difference in 1-year and long-term GL was observed in any of the other studies.

Discussion

The choice of kidney for LLDN is often based on the surgeon's preference, and RK-LLDN or MRA-LLDN are sometimes rarely performed in some centres because they were initially considered to be more difficult to remove and implant. Nevertheless, two approaches to the choice of kidney are commonly used: leave the donor with the kidney with better function and ensure maximum safety and fewest side effects for the donor while ensuring optimal recipient graft function results.

This review of the literature comprising comparative studies of RK-LLDN and MRA-LLDN shows that recovery of these kidneys is feasible and safe for donors compared to LK-LLDN and SRA-LLDN. The OT was similar or even shorter for RK-LLDN, compared to LK-LLDN, with a trend towards fewer intra-operative complications [15], but with no significant differences in terms of the rate of conversion

Table 2 Studies included in the systematic review of multiple-renal artery kidney living donor nephrectomy

Authors	Country	Years	Sample size	OT (min)	WIT (min)	Conversion	Blood transfusion	LOS (days)	DGF	Arterial complication	Ureteral complication	Graft loss (1 year/long term)	
Oh [24]	USA	2003	21	184	4.1	2 (9.5%)	–	1.5	–	–	–	0 (0%)	–
Hsu [25]	USA	2003	71	266	4.9	–	–	3.0	–	1 (1.4%)	4 (5.6%)	5 (7.0%)	–
Carter [26]	USA	2005	36	203	4.8	1 (2.8%)	1 (2.8%)	3.4	3 (8.3%)	1 (2.8%)	6 (16.7%)	1 (2.8%)	–
Desai [27]	India	2007	27	166	3.5	0 (0%)	0 (0%)	4.2	–	0 (0%)	1 (3.7%)	2 (7.4%)	–
			31	162	3.9	0 (0%)	1 (3.2%)	4.5	–	1 (3.2%)	0 (0%)	2 (6.4%)	–
Keller [14]	USA	2009	37	175	1.5	0 (0%)	0 (0%)	3.8	3 (8.1%)	1 (2.7%)	2 (5.4%)	–	3 (8.1%)
Paramesh [28]	USA	2009	60	114	1.0	0 (0%)	–	–	5 (8.3%)	3 (5.0%)	5 (8.3%)	6 (10.0%)	16 (26.7%)
Paragi [29]	USA	2011	177	128	–	1 (0.6%)	–	2.9	–	–	5/155 (3.2%)	10/155 (6.4%)	–
Meyer [30]	Brazil	2012	22	163	4.9	1 (4.5%)	–	–	1 (4.5%)	1 (4.5%)	1 (4.5%)	–	–
Cho [31]	Korea	2012	86	209	3.0	0 (0%)	2 (2.3%)	4.2	2 (2.3%)	1 (1.2%)	0 (0%)	4 (4.6%)	10 (11.3%)
Cooper [32]	USA	2013	212	207	3.3	5 (2.4%)	–	–	10 (4.8%)	–	13 (5.7%)	20 (9.4%)	–
			43	211	3.6	2 (4.7%)	–	–	5 (11.6%)	–	4 (9.8%)	6 (13.2%)	–
Omoto [33]	Japan	2014	105	320	4.9	0 (0%)	0 (0%)	3.8	0 (0%)	–	1 (1.0%)	–	6 (5.7%)
			22	365	6.1	0 (0%)	0 (0%)	4.9	0 (0%)	–	0 (0%)	–	1 (4.5%)
Al-Oraifi [34]	Saudi Arabia	2017	43	168	4.6	0 (0%)	0 (0%)	4.7	0 (0%)	0 (0%)	0 (0%)	–	–

OT operating time, *WIT* warm ischemia time, *LOS* length of stay, *DGF* delayed graft function

to open surgery (0.8% vs 0.5%, $p=0.27$), rate of blood transfusion (0.2% vs 0.6%, $p=0.25$) or LOS after the surgery. A recent meta-analysis [35] reported similar findings with a 13.4-min shorter OT for RK-LLDN, and fewer intraoperative complications for RK-LLDN (OR 0.53; 95% CI 0.31–0.92; $p=0.03$). These differences are probably due to the anatomic structures surrounding the left kidney (spleen, pancreas, splenic flexure) and vascularization of the renal vein (gonadal vein, adrenal vein, lumbar azygos veins). Various studies have reported longer OT and WIT for MRA-LLDN, corresponding to a more difficult laparoscopic procedure compared to SRA-LLDN, but these procedures were not associated with more complications among donors in terms of conversion to open surgery (1.3% vs 1.0%, $p=0.37$) and the need for blood transfusion (1.1% vs 0.8%, $p=0.51$), with no significant difference in terms of LOS.

Graft function results after RK-LLDN were also similar to those of LK-LLDN. RK-LLDN were not associated with higher 1-year and long-term GL rates, DGF rate (1.8% vs 2.0%, $p=0.76$) or vascular thrombosis rate (0.4% vs 0.2%, $p=0.19$). Only one case of venous thrombosis was reported for RK-LLDN in Maartense's study [9], in contrast to the first published series of RK-LLDN [4, 36]. These results over recent years are probably related to improvement of laparoscopic nephrectomy procedures to manage the right renal vein transection, as hand-assisted device to raise the kidney thereby extending the renal vein [11, 37] or vascular stapling devices or the use of a Satinsky atraumatic vascular clamp [18] to preserve a maximum of right renal vein length. In the RK-LLDN review, most of the authors reported the use of an endo-TA stapler to leave a staple line on the caval side only because it provides an additional length of the graft vein [11] and prevents blood stasis after the vein transection. These results are also probably related to progress in implantation techniques such as extended dissection of the external iliac vein to facilitate mobilization and reduce traction on the anastomosis [37, 38] or prolonging vein length with inverted kidney transplant [39] or renal vein extension with gonadal or saphenous graft [40] even if this back-table reconstruction is exceptionally necessary (less than five cases reported in all the review).

Graft function after MRA-LLDN seems to be different compared to SRA-LLDN. In the review, MRA-LLDN is associated with higher DGF rate compared to SRA-LLDN (4.4% vs 3.6%, $p=0.006$) but this difference is low and only Cooper [32] reported this significant difference in the three or more renal arteries group compared to dual renal artery or SRA group. Furthermore, the DGF rate varies depending on lot of donor and recipient characteristics [41] and the presence of multiple renal graft arteries could not be identified without multivariate analysis as an independent cause of DGF. Despite the need for vascular reconstruction for kidneys with MRA, including side-to-side or end-to-side anastomosis of two arteries [28], double distinct anastomosis on external and/or internal recipient iliac arteries [27], ligature of small upper pole arteries [32] or even the use of autogenous arterial grafts [33], only 2.2% of MRA graft arterial complications were reported. However, as reported in two studies [26, 32], we report in all the MRA-LLDN review significantly more ureteral complications in MRA-LLDN (4.4%) compared to SRA-LLDN (2.6%). These complications (leak or stricture) were sometimes related to injury to an inferior polar artery supplying the ureter. They were repaired surgically using a double-J ureteral stent or ureteral reimplantation, and none of the published studies reported a GL due to a ureteral complication.

These results support the strategy adopted in some institutions [17, 19] as in ours, concerning the kidney side selection criteria for LLDN: in case of morphological abnormalities or functional asymmetry between the two kidneys, the kidney with the poorer function or the abnormality is removed whether it is a RK or a MRA kidney because of the feasibility and safety of RK or MRA-LLDN for the donor; and in the absence of functional asymmetry or abnormalities, the kidney with strictly less renal arteries (LK if there is the same number of renal arteries) is taken due to the additional difficulty of MRA-LLDN due to back-table reconstruction and the increased risk of graft ureteral and functional complications. To ensure the least possible impact on donor renal function, we consider that it should be preferable to choose the kidney with a morphologic abnormality or poorer function (based on CT scan and DMSA renal scintigraphy), and that the choice of kidney should be based on anatomic considerations such as side or number of renal arteries only when no abnormalities or functional differences are observed between the two kidneys.

The review does not compare the different laparoscopic approaches for RK or MRA kidney removal, and also no study reporting robotic-assisted LLDN met the inclusion criteria. It would be interesting in the future to evaluate more precisely the different laparoscopic approaches for RK and MRA nephrectomy to determine the safest with better graft result.

This review of the literature presents a number of limitations. Only English language studies were published, included only series with at least 20 sample sizes, which can lead to a selection bias. A broader systematic search should have included multiple databases, while only Medline, ScienceDirect and Cochrane Library were used in this study. The 28 comparative studies selected comprised only one randomized controlled trial and three prospective cases. The nonrandomised comparative studies selected are at high risk of selection bias and they are heterogeneous in terms of laparoscopic surgical techniques, follow-up, definitions of the outcomes of interest and main outcome results; this is the reason why the quality of evidence of this review is

very low according to GRADE [42]. Furthermore, the procedures included in this review are mostly done in large-volume transplant institutes where most procurements are done by surgeons with high experience in laparoscopic donor nephrectomy; therefore, expertise plays a major role in the final outcomes. Most who venture in RK-LLDN and MRA-LLDN are already the seasoned surgeons who have done a lot of allografts with LK and SRA kidneys.

Conclusion

This review of the literature suggests that, on the basis of the most relevant outcomes, RK-LLDN and MRA-LLDN would be similar to LK-LLDN and SRA-LLDN in terms of feasibility and safety for the donor as well as short-term and long-term graft function results for RK-LLDN. With an appropriate laparoscopic surgical technique and preservation of graft vascular anatomy, RK-LLDN and MRA-LLDN should be considered.

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Compliance with ethical standards

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