Original Paper

Comparative Analysis of Quality of Life and Surgical Outcomes Following Laparoscopic Versus Open Living Donor Nephrectomy: A Randomized Clinical Trial

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Keywords. Donor nephrectomy; Laparoscopy; Open surgery; Clinical outcomes; Quality of life.

Introduction. This study aimed to evaluate and compare quality of life and surgical outcomes following laparoscopic donor nephrectomy (LDN) versus the standard open donor nephrectomy (ODN) technique.

Methods. This open-label randomized clinical trial was conducted at Imam Khomeini Hospital, Urmia, Iran, from 2022 to 2023). Ninety-one kidney donors were randomly assigned to the ODN (n = 46) or LDN (n = 45) group. Outcomes included hemoglobin changes, renal function, hospitalization length, operation time, time to return to normal activities, complications, and one-year quality of life (SF-36). Data were analyzed using t-tests and Chi-square tests ($P < .05$).

Results. The mean duration of surgery was significantly longer in the LDN group compared to the ODN group (3.13 ± 0.37 vs. 2.30 ± 0.37 hours; $P < .001$). However, the ODN group experienced a significantly greater reduction in hemoglobin (-1.59 ± 0.78 vs. -1.04 ± 0.94; $P = .004$) and longer hospitalization (4.06 ± 0.38 vs. 3.31 ± 0.55 days; $P < .001$). Furthermore, a significantly higher proportion of LDN patients returned to normal activities within one month of surgery (84.1% vs. 54.5%; $P = .004$). There were no significant differences regarding urinary output, complications, or long-term quality of life ($P > .05$).

Conclusion. Although laparoscopic donor nephrectomy requires a longer operative time, it offers superior clinical benefits, including reduced blood loss, shorter hospital stays, and faster functional recovery. These findings support the adoption of the laparoscopic approach as the preferred standard of care for living kidney donors to optimize postoperative recovery.

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INTRODUCTION

Chronic kidney disease (CKD) represents a significant global health burden, with renal transplantation being the optimal treatment for end-stage kidney disease (ESKD). Due to the critical shortage of deceased donor organs, living donation has become essential for expanding the donor pool.[1] Living donor transplants consistently demonstrate superior graft survival and patient outcomes compared to those from deceased donors.[2]

Traditionally, open donor nephrectomy (ODN) via a lumbar incision has been the standard surgical approach for living kidney donation.[3] However, given the typically young and healthy donor population, the significant postoperative pain and prolonged recovery associated with the large

flank incision often pose significant challenges for these individuals, hindering their timely return to normal activities and work.[4] The introduction of laparoscopic donor nephrectomy (LDN) in 1995 revolutionized living donation, offering potential benefits such as reduced pain, shorter hospital stays, and faster recovery.[5] Consequently, LDN rapidly gained prominence and is now the preferred surgical approach in many centers, demonstrating superior outcomes in terms of both donor recovery and graft function.[6]

Ensuring the safety and well-being of living donors is paramount. While donors typically report high baseline quality of life (QOL), the impact of the surgical approach on postoperative recovery remains a critical area of investigation.[7] Although LDN is widely considered superior due to early recovery, comparative data on long-term QOL and specific surgical outcomes remain inconsistent. Some studies suggest clear benefits for LDN, while recent systematic reviews indicate that long-term QOL between the two techniques may be minimally different or equivalent.[8,9] Given these mixed findings and the need for region-specific data, this study aimed to comprehensively evaluate and compare the surgical outcomes and postoperative QOL following LDN and ODN in a contemporary cohort of living kidney donors.

MATERIALS AND METHODS

tudy Design and Setting

tudy Design and Participants

This prospective, open-label, randomized clinical trial was conducted at Urmia Imam Khomeini Hospital, Iran, from June 2022 to June 2023. The study protocol was approved by the institutional Ethics Committee (IR.UMSU.HIMAM.REC.1401.063) and registered with the Iranian Clinical Trials Registry (IRCT20180625040232N10). Written informed consent was obtained from all participants prior to randomization in accordance with the Declaration of Helsinki.

Participants and Eligibility Criteria

The study enrolled 91 eligible living kidney donors aged 18–60 years with a Body Mass Index (BMI) < 35 kg/m² suitable for left-sided nephrectomy. Exclusion criteria included donors requiring right-sided nephrectomy, donors of recipients undergoing re-transplantation, and those with prior major abdominal surgery. Moreover, if a patient refused the randomized allocation, they were excluded from the study (attrition) and treated according to their preference, but not included in the analysis.

Patients were informed about the study during the screening phase. To control for operator variability, all procedures were performed by a single experienced transplant surgeon.

Data Collection and Outcome Measures

Baseline demographic data (age, sex, BMI) and clinical characteristics were recorded. Intraoperative variables included operative time (skin-to-skin). Postoperative outcomes included hemoglobin changes (difference between preoperative and day one postoperative levels), length of hospital stay (LOS), time to return to normal daily activities, and incidence of complications (categorized by Clavien–Dindo classification). Renal function was assessed by measuring serum creatinine levels and 24-hour urine output in donors.

Randomization and Intervention

Participants were randomly assigned (1:1 ratio) to either the Laparoscopic Donor Nephrectomy (LDN) group (n = 46) or the Open Donor Nephrectomy (ODN) group (n = 45) using a computer-generated random number sequence.

Operative procedure: Laparoscopic donor nephrectomy

Patients were placed in the right lateral decubitus position. A standard transperitoneal approach was applied using three trocars. Following dissection of the adrenal gland, ureter, and gonadal vessels, the renal artery and vein were secured with vascular clips. The graft was extracted via a suprapubic Pfannenstiel incision, followed by standard hemostasis and closure.

Operative procedure: Open donor nephrectomy

The procedure was performed via a standard 10–15 cm retroperitoneal flank incision extending from the 11th or 12th rib. The retroperitoneal space was accessed, and the kidney, ureter, and renal hilum were mobilized. Following ligation of collateral vessels, the renal pedicle was divided. Brisk diuresis was maintained intraoperatively using mannitol and crystalloids prior to graft preservation in ice-cold solution.

Postoperative Care and Follow-up

Postoperative management followed standard institutional protocols. Clinical data were collected for one month post-transplantation, and specific donor complications, including vascular, urological, and surgical adverse events.

Quality of Life and Satisfaction Assessment

Health-related quality of life (HRQoL) was assessed one year post-surgery and the telephone interview method was chosen to maximize long-term follow-up retention. The validated Persian version of the Short Form-36 (SF-36) questionnaire (Cronbach's $\alpha > 0.7$) was utilized. Data were collected into Physical (PCS) and Mental Component Summary (MCS) scores, with higher scores indicating better health status.

Patient satisfaction was evaluated using a customized questionnaire developed to detect patient-centered outcomes relevant to the local cultural context. The instrument assessed satisfaction with recovery speed, overall surgical outcome, and willingness to undergo the procedure again, using 5-point Likert scales ranging from "Very Satisfied" to "Not at all Satisfied. While not a standardized tool, this questionnaire was developed by the research team to assess patient-centered outcomes specific to the local cultural context of donation.

Renal function (serum creatinine level, urine output) and hematological parameters were monitored daily until discharge. Acute Tubular Necrosis (ATN) was defined as a daily serum creatinine increase of $\geq$ 0.3 mg/dL.[10]

sample size and sampling Method

The sample size was determined based on the incidence of Acute Tubular Necrosis (ATN) reported in a comparable regional study,[11] which observed rates of 37.8% in LDN and 12.1% in ODN. Although ATN is a recipient outcome, it serves as a robust proxy for graft quality and surgical stress on the kidney (donor outcome). Using a two-sided confidence interval of 95% (Z-1α/2 - 1.96) and a power of 80% (Z1-β - 0.84%), a minimum sample size of 44 patients per group was determined to detect a significant difference.

$$n = \frac{(Z_{1-\frac{\alpha}{2}} + Z_{1-\beta})^2 \times [P_1(1-P_1) + (1-P_2)]}{(P_1 - P_2)^2}$$

Statistical Analysis

Data were analyzed using IBM SPSS Statistics software, version 22.0. The normality of continuous variables was assessed using the Shapiro-Wilk test.

- Normally distributed continuous variables (e.g., age, operative time) were reported as mean ± standard deviation (SD) and compared using the Independent Student's t-test.
- Non-normally distributed variables were reported as median (interquartile range) and compared using the Mann-Whitney U test.
- Categorical variables (e.g., complication rates, gender) were summarized as frequencies and percentages and compared using the Chi-square test or Fisher's Exact test, as appropriate.
- A *P*-value of < .05 was considered statistically significant.

RESULTS

The final analysis included 46 patients in the ODN group and 45 patients in LDN group. The demographic and operative data are summarized in Table 1. The cohort showed a male predominance (63%). There were no significant differences between the two groups regarding sex distribution (*P* = .93), mean age (*P* = .06), or Body Mass Index

Table 1. Demographic characteristics and operative data of kidney donors

Parameter	Open Donor Nephrectomy (n=46)	Laparoscopic Donor Nephrectomy (LDN) (n=45)	*P*
Gender (n%)			
Male	29 (63%)	28 (62.2%)	.93
Female	17 (37%)	17 (37.8%)	
Mean age of Donor (year)	30.80 ± 4.62	28.13 ± 4.77	.06
Mean BMI (kg/m^2)	25.6 ± 2.08	24.49 ± 2.86	.28
Mean operative time (hour)	2.30 ± 0.37	3.31 ± 0.37	< .001
Mean hospital stay (day)	4.06 ± 0.38	3.31 ± 0.55	.001

**P*-values calculated using Chi-square test for categorical variables and Independent t-test for continuous variables.

(BMI) (P = .28). However, a significant difference was observed in operative parameters. The mean operative time was significantly longer in the LDN group (3.31 ± 0.37 hours) compared to the ODN group (2.30 ± 0.37 hours; P < .001). Conversely, the mean length of hospital stay was significantly shorter in the LDN group (3.31 ± 0.55 days) compared to the ODN group (4.06 ± 0.38 days; P = .001).

Laboratory Outcomes and Renal Function

Table 2 shows the comparison of the laboratory parameters on admission and discharge. Baseline values for donor hemoglobin levels and WBC counts were comparable between groups (P > .05). However, the decline in hemoglobin levels from admission to discharge was significantly lower in the LDN group (mean change: -1.04 ± 0.94 g/dL) compared to the ODN group (mean change: -1.59 ± 0.78 g/dL; P = .004), indicating reduced surgical blood loss in the laparoscopic group. Donor serum creatinine increased significantly at discharge in both groups as expected after nephrectomy, with no significant difference in the magnitude of increase between the two techniques (P = .67).

Urinary Output

Both groups showed a significant increase in recipient urine output from the intraoperative period to the postoperative ward phase. Although the LDN group had a higher absolute urine volume in the ward (12,491 mL vs. 11,035 mL; P = .04), the mean change in output was not statistically significantly different between the two groups (P = .15) (Table 3).

Quality of Life and Patient Satisfaction

During the one-year follow-up, there was no statistically significant difference in the mean SF-36 scores between the LDN group (77.40 ± 7.93) and the ODN group (75.88 ± 9.50; P = .41). However, regarding recovery time, a significantly higher proportion of donors in the LDN group returned to their normal daily activities within one month compared to the ODN group (84.1% vs. 54.5%; P = .04). Specifically, 38.6 % of LDN donors returned to normal activity in less than two weeks, compared to only 22.7% of ODN donors (Table 4). Other satisfaction metrics (overall satisfaction, willingness to repeat) showed no significant differences.

Table 2. Comparison of laboratory parameters at admission and discharge

Variables	Open Donor Nephrectomy			*P1*	Laparoscopic Donor Nephrectomy			*P2*	*P3*	*P4*
	Admission	Discharge	Mean Change		Admission	Discharge	Mean change			
Recipient Creatinine (mg/dL)	8.41 ± 1.97	1.46 ± 0.32	-6.95 ± 0.32	.001	9.61 ± 2.29	1.37 ± 0.29	-8.23 ± 2.29	.001	.009	.005
Donor Creatinine (mg/dL)	1.04 ± 0.32	1.54 ± 0.23	0.49 ± 0.24	.001	1.05 ± 0.15	1.57 ± 0.24	0.51 ± 0.24	.001	.71	.67
Donor Hemoglobin (g/dL)	15.42 ± 1.05	13.83 ± 1.02	-1.59 ± 0.78	.001	15.62 ± 1.29	14.57 ± 1.37	-1.04 ± 0.94	.001	.41	.004
Donor WBC Count (×10^3/µL)	6.31 ± 1.92	9.94 ± 2.76	3.63 ± 2.17	.001	6.83 ± 1.65	9.7 ± 2.71	2.86 ± 2.44	.001	.0	.09¥

P1: Intragroup comparison (admission and discharge time) in the ODN group; *P2* : Intragroup comparison (admission and discharge time) in the LDN group; *P3*: Comparison of mean values at the beginning of hospitalization (Baseline) between the two groups; *P4*: Comparison of mean changes (within changes) between two groups;
¶Paired t-test; ¶¶Wilcoxon Rank test; ¥Independent t-test; ¥¥Mann Whitney U test

Table 3. Comparison of recipient urine output (mL/24h)

Time Point	Intraoperative	Postoperative (Ward)	Mean Change	*P*1
Open Donor Nephrectomy	907.61 ± 431.01	11035.86 ± 3507.08	10128.26 ± 3290.21	.001
Laparoscopic Donor Nephrectomy	1310.22 ± 253.2	12491.11 ± 3011.02	11180.88 ± 3603.69	.001
*P*2	0.29	0.04	0.15	

*P*1: Comparison within groups using Paired t-test.; *P*2: Comparison of means between two groups using Independent t-test

Table 4. Postoperative Quality of Life (SF-36) and Patient Satisfaction Outcomes

Satisfactory questions	Outcome Measure	Open Donor Nephrectomy n (%)	Laparoscopic Donor Nephrectomy n (%)	*P*
Time to return to daily activities after surgery	Very satisfied	38 (86.4%)	40 (90.9%)	.47
	satisfied	2 (4.5%)	2 (4.5%)	
	Moderately satisfied	1 (2.3%)	0	
	Not satisfied	3 (6.8%)	2 (4.5%)	
	Not at all satisfied	0	0	
Overall Surgical Satisfaction	Very satisfied	40 (90.9%)	40 (90.9%)	.56
	satisfied	3 (6.8%)	4 (9.1%)	
	Moderately satisfied	0	0	
	Not satisfied	1 (2.3%)	0	
	Not at all	0	0	
Willingness to Undergo Procedure Again	Definitely	40 (90.9%)	2 (4.5%)	.34
	Maybe	1 (2.3%)	42 (95.5%)	
	Not sure	1 (2.3%)	2 (4.5%)	
	Probably not	0	0	
	Definitely not		0	
Time to Return to Normal Activities	< 2 weeks	10 (22.7%)	0	.04
	2 - 4 weeks	14 (31.8%)		
	4 - 8 weeks	4 (9.1%)		
	2 -3 months	11 (25%)		
	< 3 months	5 (11.4%)		
SF-36 Total Score (Mean ± SD)	-	75.88 ± 9.5	77.40 ± 7.93	.41

Complications

Postoperative complications were categorized according to the Clavien–Dindo classification (Table 5). There was no statistically significant difference in the overall complication rate between the ODN group (43.1%) and the LDN group (36.4%; $P = .57$).

Donor Complications

pecific complications affecting the donors varied by surgical approach. In the ODN group, pneumothorax requiring chest tube insertion was observed in 3 patients (6.8%), whereas no pneumothorax occurred in the LDN group. Conversely, the LDN group experienced one case of intraoperative bladder rupture (2.3%) during graft extraction and one case of chylous ascites (2.3%), neither of which occurred in the ODN group. Vascular injuries, specifically transection of the superior polar artery, occurred in 3 ODN donors (6.8%) and 2 LDN donors (4.5%).

Recipient Outcomes

Complications affecting the graft recipient were comparable between the groups. Acute Tubular Necrosis (ATN) was the most frequent recipient complication, affecting 18.2% of the ODN group and 15.9% of the LDN group. Delayed Graft Function (DGF) occurred in two recipients of ODN (4.5%) and one recipient of LDN (2.3%). Graft loss requiring transplant nephrectomy occurred in threecases in the ODN group (6.8%) and two cases in the LDN group (4.5%).

Grade I and II complications (e.g., minor infections) occurred in 29.5% of ODN and 27.4 % of LDN patients. More serious complications (Grade III/IV), such as pneumothorax requiring chest tube insertion or reoperation, were rare and comparable between the two groups. Specific complications included recipient acute tubular necrosis (ATN)

Table 5. Incidence of Postoperative Complications (Clavien–Dindo Classification)

Variable	Open Donor Nephrectomy (n = 46)	Laparoscopic Donor Nephrectomy (n = 45)	*P*
Overall Complication Rate	21 (43.1%)	17 (36.4%)	
Donor-Specific Complications			
Pneumothorax	3 (6.8%)	0 (0.0%)	.57
Sup. Polar Artery Transection	3 (6.8%)	2 (4.5%)	
Urinary Retention	0 (0.0%)	1 (2.3%)	
Bladder Rupture	0 (0.0%)	1 (2.3%)	
Chylous Ascites	0 (0.0%)	1 (2.3%)	
Re-operation (Drain/Bleeding)	0 (0.0%)	1 (2.3%)	
Recipient-Specific Complications			
Acute Tubular Necrosis (ATN)	8 (18.2%)	7 (15.9%)	
Delayed Graft Function (DGF)	2 (4.5%)	1 (2.3%)	
Recipient Nephrectomy (Graft Loss)	3 (6.8%)	2 (4.5%)	
Clavien–Dindo Classification			
Grade I - II	13 (29.5%)	12 (27.4%)	
Grade III	3 (6.8%)	2 (4.5%)	
Grade IV	3 (6.8%)	2 (4.5%)	
Grade V	0 (0.0%)	0 (0.0%)	

(18.2% ODN vs. 15.9% LDN), donor transection of the superior polar artery (6.8% ODN vs. 4.5% LDN), and donor pneumothorax (6.8% in ODN vs. 0% in LDN).

DISCUSSION

Living donor nephrectomy poses surgical challenges, as it entails a healthy individual undergoing a major surgical procedure for the altruistic benefit of another. This inherently carries a significant degree of emotional and physical burden on the donor.[11,12] This randomized open-label clinical trial aimed to comprehensively compare the surgical outcomes and quality of life (QOL) between Laparoscopic Donor Nephrectomy (LDN) and Open Donor Nephrectomy (ODN) in a contemporary cohort of Iranian donors.

Our findings showed that LDN offers significant advantages regarding immediate postoperative recovery. We observed a significantly shorter length of hospital stay in the LDN group compared to the ODN group. This finding is consistent with numerous randomized trials and meta-analyses, which consistently report reduced hospitalization times for laparoscopic donors due to smaller incisions and less postoperative pain.[13,14] Furthermore, our study found that LDN donors returned to normal daily activities significantly faster than ODN donors. This faster functional recovery is a critical patient-centered outcome, as it minimizes the socioeconomic burden on donors who often need to return to work or domestic responsibilities.

However, in contrast to certain reports indicating that LDN is a more expedited procedure,[15] our data showed that the average operative duration was significantly longer in the LDN group compared to the ODN group. This finding aligns with a study by Cheema *et al.*,[16] which noted that laparoscopic procedures generally require longer operative times due to the technical complexity of dissection and graft extraction. While some high-volume centers report equivalent operation times,[17] the longer duration in our cohort confirms the meticulous nature of the laparoscopic approach or the learning curve inherent to the technique in our setting.[18] Importantly, despite the longer operative time, the incidence of complications was not higher in the LDN group.

We observed significantly less hemoglobin reduction in the LDN group compared to the ODN group, indicating reduced intraoperative blood loss. This is a well-established benefit of the laparoscopic approach, attributable to the magnification provided by the camera and the use of precise hemostatic devices.[19] Regarding safety, there was no statistically significant difference in the overall complication rate between the two groups. The majority of complications were minor (Grade I-II), which were graded using the Clavien–Dindo classification, a widely accepted standardized grading system.[20,21] These findings indicate that

LDN demonstrates a comparable safety profile compared to the open technique when performed by experienced teams, without increasing the risk of significant morbidity.[22]

A key objective of this study was to assess long-term donor QOL. At the one-year follow-up, SF-36 scores were higher in the LDN group than in the ODN group, but this difference did not reach statistical significance. This result mirrors the findings of Anderson *et al*.[23] and meta-analysis study,[24] which suggest that while LDN provides immediate benefits in pain and recovery, the long-term QOL equilibrates between the two groups once the donors have fully recovered. Therefore, while we cannot claim that LDN offers superior long-term QOL based on our data, the significant advantage in early recovery (return to normal activities) supports its use as the preferred technique to minimize the acute burden of donation.[25]

Both groups exhibited favorable recipient outcomes as there are many other factors affecting the kidney function, including the immunosuppression regimen, recipient age, presence or absence of diabetes mellitus in recipients, peripheral atherosclerosis and other factors.[26] Notably, recipients of laparoscopic grafts demonstrated a statistically greater reduction in serum creatinine levels at discharge, despite the longer operative and warm ischemia times inherent to the laparoscopic technique.[27] This finding confirms that the moderate increase in warm ischemia associated with laparoscopy did not detrimentally affect early graft function in our cohort.[28] Furthermore, the lack of significant difference in donor creatinine elevation suggests that the surgical approach (laparoscopic vs. open) does not differentially affect the acute function of the donor's remaining kidney.[29] Overall, the comparable urine output and robust creatinine reduction in both recipient groups reinforce that the extended ischemia times characteristic of LDN are well-tolerated and do not compromise immediate graft viability.

Limitations of study

This study has several limitations. First, QOL was assessed via telephone interview one year post-operatively, which may introduce recall bias and fails to detect the dynamic changes in QOL during the immediate postoperative period (weeks 1–12), where LDN advantages are typically most pronounced. Second, satisfaction was assessed using a non-validated questionnaire, which limits the generalizability of these specific findings. Third, although this was a randomized trial, the single-center design may limit the external validity of the results to centers with different surgical volumes or protocols. Finally, we did not perform a formal cost-effectiveness analysis; therefore, conclusions regarding the economic impact of the procedures cannot be drawn from our data.

CONCLUSION

In conclusion, Laparoscopic Donor Nephrectomy is associated with a longer operative time but offers significant clinical advantages over Open Donor Nephrectomy, including reduced blood loss, shorter hospital stay, and a faster return to normal daily activities. While long-term quality of life appears comparable between the two techniques, the accelerated recovery profile of LDN supports its continued use as the standard of care for living kidney donation.

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Competing interests

The authors have no competing interests to declare.

Consent to participate

Informed consent was obtained from all individual participants included in the study.

Author contributions

S F: Conceptualization, the original draft writing, investigation, writing including reviewing and editing and investigation and formal analysis; A T A: Conceptualization, supervision, and project administration; H B: Conceptualization, the original draft writing, investigation.

Ethics approval

This study was performed in line with the principles of the Declaration of Helsinki. Approval was granted by the Ethics Committee of Urmia University of Medical sciences (No. : IR.UMSU.

HIMAM.REC.1401.013). It is also registered in the Iranian Clinical Trials Registry (IRCT) with the code IRCT20180625040232N10.

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REFERENCES

1. Thurlow JS, Joshi M, Yan G, Norris KC, Agodoa LY, Yuan CM, et al. Global epidemiology of end-stage kidney disease and disparities in kidney replacement therapy. American journal of nephrology. 2021 Jul 12;52(2):98-107. doi.org/10.1159/000514550
2. Dageforde LA, Moore DR, Landman MP, Feurer ID, Pinson CW, Poulose B, et al. Comparison of open live donor nephrectomy, laparoscopic live donor nephrectomy, and hand-assisted live donor nephrectomy: a cost-minimization analysis. journal of surgical research. 2012 Aug 1;176(2):e89-94. doi.org/10.1016/j.jss.2011.12.013
3. Saifee Y, Bhatia S, Chamania CS, Salgia P, Kriplani J, Sepaha A. Introduction of Laparoscopic Donor Nephrectomy: Challenges, Outcomes and Success Strategies. Int J Organ Transplant Med. 2021;12(1):23-31. PMID: 34987730; PMCID: PMC8717876.
4. Vernadakis S, Marinaki S, Darema M, Soukouli I, Michelakis IE, Beletsioti C, Zavvos G, Bokos I, Boletis IN. The Evolution of Living Donor Nephrectomy Program at A Hellenic Transplant Center. Laparoscopic vs. Open Donor Nephrectomy: Single-Center Experience. J Clin Med. 2021 Mar 12;10(6):1195. doi: 10.3390/jcm10061195.
5. Ratner LE, Ciseck LJ, Moore RG, et al. Laparoscopic live donor nephrectomy. Transplantation 1995;60:1047.
6. Wang L, Zhu L, Xie X, Wang H, Yin H, Fang C, Dai H. Long-term outcomes of laparoscopic versus open donor nephrectomy for kidney transplantation: a meta-analysis. Am J Transl Res. 2020 Oct 15;12(10):5993-6002. PMID: 33194009; PMCID: PMC7653626.
7. Thuluvath AJ, Peipert J, Berkowitz R, Siddiqui O, Whitehead B, Thomas A, et al. Donor quality of life after living donor liver transplantation: a review of the literature. Dig Med Res. 2021 Sep;4:49. doi: 10.21037/dmr-20-151.
8. Gupta A, Ahmed K, Kynaston HG, Dasgupta P, Chlosta PL, Aboumarzouk OM. Laparoendoscopic single-site donor nephrectomy (LESS-DN) versus standard laparoscopic donor nephrectomy. Cochrane Database Syst Rev. 2016 May 27;2016(5):CD010850. doi: 10.1002/14651858.CD010850.
9. Autorino R, Brandao LF, Sankari B, Zargar H, Laydner H, Akça O, et al. Laparoendoscopic single-site (LESS) vs laparoscopic living-donor nephrectomy: a systematic review and meta-analysis. BJU Int. 2015 Feb;115(2):206-15. doi: 10.1111/bju.12724.
10. El-Khoury JM, Hoenig MP, Jones GRD, Lamb EJ, Parikh CR, Tolan NV, Wilson FP. AACC Guidance Document on Laboratory Investigation of Acute Kidney Injury. J Appl Lab Med. 2021 Sep 1;6(5):1316-1337. doi: 10.1093/jalm/jfab020.
11. Alessimi A, Adam E, Haber GP, et al. LESS living donor nephrectomy: Surgical technique and results. Urol Ann. 2015;7(3):361-5. doi.org/10.4103/0974-7796.160321.
12. Keleş A, Kaya C. A comparison of pre-and post-operative outcomes in living donors undergoing transperitoneal laparoscopic nephrectomy and open nephrectomy: a retrospective single-center study. Sao Paulo Medical Journal. 2023 Dec 8;142:e2022488. doi: 10.1590/1516-3180.2022.0488.R1.070723.
13. Perry KT, Freedland SJ, Hu JC, Phelan MW, Kristo B, Gritsch AH, et al. Quality of life, pain and return to normal activities following laparoscopic donor nephrectomy versus open mini-incision donor nephrectomy. J Urol. 2003 Jun;169(6):2018-21. doi: 10.1097/01.ju.0000067975.59772.b6
14. Carrión DM, Gómez Rivas J, Aguilera Bazán A, Alonso Y Gregorio S, De Castro Guerín C, Álvarez-Maestro M, et al. Laparoscopic donor nephrectomy versus open donor nephrectomy: Outcomes from a single transplant center. Arch Esp Urol. 2019 Jun;72(5):508-514. English, Spanish. PMID: 31223128.
15. Hong YL, Yee CH, Leung CB, Teoh JY, Kwan BC, Li PK, Hou SS, Ng CF. Characteristics and clinical outcomes of living renal donors in Hong Kong. Hong Kong Med J. 2018 Feb;24(1):11-17. doi: 10.12809/hkmj176820.
16. Cheema MJ, Hassan MMU, Asim A, Nathaniel E, Shafeeq MI, Tayyab MA, et al. Innovations in Hybrid Laparoscopic Surgery: Integrating Advanced Technologies for Multidisciplinary Cases. Cureus. 2024 Jun 26;16(6):e63219. doi: 10.7759/cureus.63219.
17. Cheng H, Chen BP, Soleas IM, Ferko NC, Cameron CG, Hinoul P. Prolonged Operative Duration Increases Risk of Surgical Site Infections: A Systematic Review. Surg Infect (Larchmt). 2017 Aug/Sep;18(6):722-735. doi: 10.1089/sur.2017.089.
18. Luo Y, Wang J, Yan Z, He J, Fu L, Wang S, et al. Enhancing laparoscopic surgery training: a comparative study of traditional models and automated error detection system. BMC Med Educ. 2025 May 8;25(1):677. doi: 10.1186/s12909-025-07242-3.
19. Mehmood Y, Bashir A, Hussain Z, Sulaiman M, Gul H, Ali M. Examining the Advantages and Disadvantages of Laparoscopic Versus Traditional Open Surgeries in Terms of Recovery, Complication Rates, and Long-Term Outcomes. Indus Journal of Bioscience Research. 2025 Mar 31;3(3):599-612.
20. Katayama H, Kurokawa Y, Nakamura K, et al. Extended Clavien-Dindo classification of surgical complications: Japan clinical oncology group postoperative complications criteria. J Surg Today. 2016;46(6):668–685. doi: 10.1007/s00595-015-1236-x .
21. Bolliger M, Kroehnert J, Molineus F, et al. Experiences with the standardized classification of surgical complications (Clavien-Dindo) in general surgery patients. Eur Surg. 2018;50(6):256–261. doi: 10.1007/s10353-018-0551-z
22. Saifee Y, Chamania CS, Bhatia S, Salgia P, Kriplani J, Sepaha A. Safe transition from open to pure laparoscopic donor nephrectomy: Approach and results. Urol Ann. 2021 Oct-Dec;13(4):384-390. doi: 10.4103/UA.UA_56_20.

23. Andersen MH, Mathisen L, Veenstra M, Oyen O, Edwin B, Digernes R, et al. Quality of life after randomization to laparoscopic versus open living donor nephrectomy: long-term follow-up. Transplantation. 2007 Jul 15;84(1):64-9. doi: 10.1097/01.tp.0000268071.63977.42.

24. Wang L, Zhu L, Xie X, Wang H, Yin H, Fang C, Dai H. Long-term outcomes of laparoscopic versus open donor nephrectomy for kidney transplantation: a meta-analysis. Am J Transl Res. 2020 Oct 15;12(10):5993-6002. PMID: 33194009.

25. Van Pilsum Rasmussen SE, Robin M, Saha A, Eno A, Lifshitz R, et al. The Tangible Benefits of Living Donation: Results of a Qualitative Study of Living Kidney Donors. Transplant Direct. 2020 Nov 10;6(12):e626. doi: 10.1097/TXD.0000000000001068.

26. Thongprayoon C, Miao J, Jadlowiec CC, Mao SA, Mao MA, Leeaphorn N, Kaewput W, Pattharanitima P, Tangpanithandee S, Krisanapan P, Nissaisorakarn P, Cooper M, Cheungpasitporn W. Differences between Kidney Transplant Recipients from Deceased Donors with Diabetes Mellitus as Identified by Machine Learning Consensus Clustering. J Pers Med. 2023 Jul 3;13(7):1094. doi: 10.3390/jpm13071094.

27. Tuğcu V, Şahin S, Yiğitbaşı İ, Şener NC, Akbay FG, Taşçı Aİ. Laparoscopic donor nephrectomy, complications and management: a single center experience. Turk J Urol. 2017 Mar;43(1):93-97. doi: 10.5152/tud.2016.44711.

28. Tennankore KK, Kim SJ, Alwayn IP, Kiberd BA. Prolonged warm ischemia time is associated with graft failure and mortality after kidney transplantation. Kidney Int. 2016 Mar;89(3):648-58. doi: 10.1016/j.kint.2015.09.002.

29. Essber H, Cohen B, Artis AS, Leung SM, Maheshwari K, Khan MZ, et al. Renal injury after open versus laparoscopic non-cardiac surgery: a retrospective cohort analysis. Braz J Anesthesiol. 2021 Jan-Feb;71(1):50-57. doi: 10.1016/j.bjane.2020.12.008.

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