Comparison of Clinical Outcomes of Hand-Assisted Retroperitoneoscopic with the Hand-Assisted Laparoscopic Donor Nephrectomy in Healthy Kidney Donors

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ABSTRACT

Objective: To compare the outcomes of hand-assisted laparoscopic (HALS) and hand-assisted retroperitoneoscopic (HARS) donor nephrectomy procedures.

Study Design: Descriptive study.

Place and Duration of the Study: Pakistan Kidney and Liver Institute and Research Centre (PKLI & RC), Lahore, Pakistan, from May 2018 to December 2022.

Methodology: Data from 358 donors were analysed for pre- and postoperative outcomes of HALS and HARS donor nephrectomies, considering techniques based on clinical judgement and donor characteristics, covering demographics, pre- and postoperative complications under multidisciplinary oversight.

Results: In a group of 358 donors, the median age was 36 years, with an interquartile range (IQR) of 29-44 years, and the median (IQR) body mass index (BMI) was 25.82 (22.57-28.53). Most donors were female (58.7%) and had blood type O (47.8%). A majority had no prior surgeries (86.0%). HALS donor nephrectomies were performed in 36.3% and HARS donor nephrectomies in 63.7%, with left kidneys predominantly procured (98.3%). The median warm ischaemia time (WIT) was 88.00 seconds (IQR: 17.25). No complications were reported in 95.5% of cases. Pain scores at 12 hours ($p < 0.001$), 24 hours ($p < 0.001$), 48 hours ($p < 0.001$), and 10 days ($p = 0.028$), along with the length of hospital stay (LOS) ($p < 0.001$), displayed significant differences in their distributions across procedures. HARS donor nephrectomies showed better pain management, while both techniques had similar outcomes for early bowel movement within 48 hours.

Conclusion: The study results emphasise tailored surgical approaches and meticulous postoperative care in live kidney donation surgeries. HARS technique offers advantages in postoperative pain management, contributing to optimising donor outcomes and surgical techniques.

Key Words: *Live kidney donation, Hand-assisted laparoscopic surgery, Hand-assisted retroperitoneal surgery, Laparoscopic donor nephrectomy, Surgical outcomes, Perioperative complications*.

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INTRODUCTION

The surgical landscape in renal transplantation has witnessed significant advancements over the years, driven by the pursuit of optimising outcomes for both donors and recipients. Among the various surgical approaches, hand-assisted laparoscopic surgery (HALS) and hand-assisted retroperitoneoscopic surgery (HARS) have emerged as viable techniques for nephrectomy in healthy kidney donors.

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The imperative to strike a balance between maximising donor safety and ensuring optimal graft function has fueled ongoing debates and investigations into the comparative clinical outcomes of these procedures. In recent decades, laparoscopic approaches to nephrectomy have gained prominence owing to their minimally invasive nature, resulting in reduced postoperative pain, shorter hospital stays, and quicker recovery times when compared to traditional open procedures.[1] HALS is a notable representative of this paradigm shift, allowing surgeons to combine the benefits of minimally invasive techniques with the tactile feedback provided by the surgeon's hand within the operative field.[2] HALS has demonstrated efficacy in minimising warm ishaemia time (WIT), a critical factor influencing postoperative graft function.[3] However, the advent of HARS has introduced an alternative approach, emphasising the retroperitoneal space for donor nephrec-

tomy. The retroperitoneal route offers a more direct path to the kidney, potentially reducing operative times (OT) and the risk of intra-abdominal complications.[4]

While the benefits of laparoscopic techniques are apparent, the choice between HARS and HALS remains a subject of ongoing investigation. Limited comparative studies have been conducted to comprehensively assess the clinical outcomes of these two approaches in the context of healthy kidney donors. Early evidence suggests that HARS may be associated with shorter OT and reduced intraoperative complications, but the impact on postoperative pain, donor's bowel function, graft function, and other critical endpoints requires more in-depth exploration.[5]

Several studies have focused on individual aspects of these procedures, such as WIT, donor pain, and postoperative recovery. For instance, a retrospective study by Saifee *et al*. highlighted the potential advantages of HARS donor nephrectomy in minimising WIT, thus contributing to improved graft outcomes.[6] Conversely, a qualitative descriptive approach by Dreesmann *et al.* underscored the importance of assessing postoperative pain and recovery times in donors undergoing HALS donor nephrectomy, suggesting that these factors play a pivotal role in the overall donor experience.[7]

Understanding the nuances of each surgical approach is crucial for informed decision-making and optimising outcomes for healthy kidney donors. The rationale of this study was to explore not only OT, WIT, length of hospital stay (LOS) and intraoperative complications but also delve into patient-reported outcomes such as postoperative pain and bowel movement. This may provide evidence-based guidance for surgeons and healthcare providers in selecting the most appropriate surgical approach tailored to the unique needs of healthy kidney donors, ultimately improving the safety and well-being of individuals contributing to the noble cause of kidney donation and transplantation. The objective of this study was to compare the outcomes of HALS and HARS donor nephrectomy procedures.

METHODOLOGY

This descriptive study, conducted retrospectively at the Department of Kidney Transplant, Pakistan Kidney and Liver Institute and Research Centre, Lahore, Pakistan, from May 2018 to December 2022, was approved by the Institutional Review Board of the hospital (PKLI-IRB/AP/99). Informed consent was waived, as the study utilised anonymised medical records and posed minimal risk to patient privacy. A total of 358 patients who underwent either HALS or HARS donor nephrectomy were included after Institutional Review Board approval. Cases with incomplete or missing preoperative or postoperative data, and donors who were lost to follow-up before the completion of 1st postoperative year were excluded. Patients were selected using a non-random, purposive sampling approach based on the surgeon's evaluation of donor suitability for HALS or HARS. Surgeons employed clinical judgement and donor anatomy considerations to determine the most suitable surgical technique for each participant. Data were extracted from a dedicated kidney transplant database for all donors who underwent HARS or HALS Donor nephrectomies. Each donor was evaluated based on PKLI's standard protocol, with the Kidney Transplant Selection Committee, including surgeons, nephrologists, immunologists, and transplant coordinators, making final decisions on donor suitability. The committee selected which kidney to procure, aiming to leave the better-functioning kidney with the donor. The surgical team determined the appropriate laparoscopic technique, focusing on preserving the better-functioning kidney. All donors received standardised pre- and postoperative care, including clinic follow-up. Both groups were given general anaesthesia, and surgical positioning was standardised. For HALS, a midline supraumbilical incision was used for hand-port placement, followed by the insertion of two additional ports. The first 12-millimetre port was precisely positioned in the respective lower abdominal quadrant, guided by the surgeon's hand, with insufflation of carbon dioxide (CO_2) up to 15 mmHg (millimetres of mercury). Subsequently, the 11-millimeter principal camera port was placed in the respective upper abdominal quadrant, facilitating kidney dissection and retrieval. Descending or ascending colon was first mobilised for left or right side nephrectomy, respectively, followed by dissection of the kidney, ureter, and vascular structures, which was meticulously performed with the LigaSure device, assisted by the surgeon's hand through the hand port. After completion of dissection, the ureter was coagulated and transected distally with the LigaSure device, followed by division of the renal artery and vein using a stapler device. The kidney was retrieved through the open handport.

In the HARS technique, a Pfannenstiel incision, typically used in gynaecological surgeries, was employed for hand-port insertion. This incision is made just above the pubic symphysis, providing access to the retroperitoneum. Following the incision, blind retroperitoneal dissection was performed to create sufficient space behind the peritoneum. The first trocar was inserted into the respective lower abdominal quadrant to facilitate access to the retroperitoneum, similar to the HALS technique's 12 mm port. CO_2 was insufflated to distend the retroperitoneum and facilitate visualisation. A second trocar was placed in the respective upper abdominal quadrant, akin to the HALS 11 mm camera port. The dissection focused on identifying and separating the kidney's vascular structures and ureter from surrounding tissues. The techniques for dissection of the kidney, ureter, and renal vasculature as well as the transection of ureter and renal vasculature are similar to that utilised in HALS. The kidney was then delivered through the handport, which provided direct access for retrieval. Postoperatively, no drains were used, and standard closure procedures were followed. Postoperative care included a tailored intravenous fluid and analgesia regimen and diligent follow-up by the transplant department at PKLI and RC.

Retrospective data, sourced from dedicated kidney transplant database, encompassed donor parameters including preoperative renal measures such as serum creatinine levels and BMI. Factors such as OT, WIT, and organ site were meticulously documented. Kidney function (creatinine, GFR) pre- and post-surgery was monitored for donors. Cases requiring conversion from laparoscopic to open surgery were scrutinised. Postoperative assessments included pain scores at 12, 24, 48 hours, and 10 days, time to first bowel movement, laxative, suppository/enema use, postoperative vomiting, analgesic consumption, and LOS. Postoperative complications were graded using the Clavien-Dindo classification system.

Statistical analysis, performed using SPSS 20, expressed continuous variables as mean values with standard deviations, median, and IQR, while categorical variables were expressed as counts and percentages. Bivariate analysis compared selected variables in HALS and HARS cohorts. For categorical variables, the Chi-square test was applied. For continuous variables, normality was tested using Shapiro-Wilk's test; those that were non-normally distributed ($p < 0.05$), differences between groups were tested using the Mann-Whitney U test with significance set at $p < 0.05$.

RESULTS

The donor demographics in Table I indicate a median age of 36.00 years (IQR: 15.00) and a median BMI of 25.82 (IQR: 5.96). The analysis of the donor-recipient relationship in this study showcases a diverse distribution among various familial ties. Brothers constituted the largest percentage at 101 (28.2%), followed by sisters at 56 (15.6%), and wives at 46 (12.8%). Other relationships included cousins 26 (7.3%), sons 11 (3.1%), fathers 24 (6.7%), and mothers 39 (10.9%). The demographic characteristics revealed a slight predominance of female donors 210 (58.7%) compared to male donors 148 (41.3%). Blood group analysis showed a majority of donors with blood type O 171 (47.8%), followed by blood types B 115 (32.1%) and A 58 (16.2%). BMI categorisation indicated that a significant proportion of donors were classified as overweight 149 (41.6%), while 124 (34.6%) were within the healthy weight range. The prevalence of infectious markers showed 40 (11.2%) of donors testing positive for Hep B Core Antigen, 17 (4.7%) positive for Anti HCV, and 333 (93.0%) positive for the Epstein-Barr Virus (EBV). Notably, 308 (86.0%) of donors reported no history of previous surgeries, indicating a predominantly healthy donor pool. The donor creatinine preoperative is median 0.76 mg/dL (IQR: 0.22) for the HALS group and median 0.72 mg/dL (IQR: 0.25) for the HARS group. The surgical approach was divided between HALS and HARS, constituting 130 (36.3%) and 228 (63.7%), respectively.

No conversion to open surgery was reported, and re-exploration was rare, occurring in 1 (0.3%) case with a port site hernia. Postoperatively, 343 (95.8%) donors had Foley catheters removed on the first day. Surgical complications were infrequent, with 342 (95.5%) donors having no complications. Some of the donors' intra- and post-operative data are presented in Table II.

These findings suggest an improvement in postoperative pain management, as indicated by decreasing mean pain scores, which reflect better patient comfort. The data offers a comprehensive view of the parameters involved in organ donation, setting the stage for further analysis and decision-making. Significant associations were identified between patient characteristics and surgical procedures. BMI Category also shows a significant association with procedure type ($\chi^2 = 25.745$, $df = 3$, $p < 0.001$), indicating different BMI distributions between HALS and HARS. History of previous surgery shows a significant association with procedure type ($\chi^2 = 18.240$, $df = 8$, $p = 0.019$), reflecting diverse surgical histories. Kidney procured also has a significant association with procedure type ($\chi^2 = 5.834$, $df = 1$, $p = 0.016$), indicating variability in procurement methods. Audible bowel sounds are highly significantly associated with procedure type ($\chi^2 = 67.684$, $df = 3$, $p < 0.001$), demonstrating distinct distributions. Vomiting shows a significant association with procedure type ($\chi^2 = 6.409$, $df = 1$, $p = 0.011$), suggesting differences in postoperative vomiting. These results deepen the understanding of how patient characteristics impact surgical procedures and outcomes.

Independent-sample Mann-Whitney U tests were conducted to analyse variable distributions across procedure categories. Due to non-normal distributions, the Mann-Whitney U test was chosen. For donor age, eGFR on DTPA renal scan, donor creatinine preoperative, donor creatinine clearance preoperative, donor ACR, operative blood loss, and WIT, the null hypothesis was retained ($p > 0.05$), showing no significant differences. However, donor BMI and donor OT exhibited significant differences ($p < 0.05$), indicating variations in these metrics. Pain scores at 12 hours ($p < 0.001$), 24 hours ($p < 0.001$), 48 hours ($p < 0.001$), and 10 days ($p = 0.028$), were significantly different across procedure categories. There was a statistically significant difference in the median LOS between the two procedure groups ($p < 0.001$), suggesting varying patient recovery times linked to different surgical techniques. Donor creatinine preoperative levels did not show a statistically significant difference between the procedure groups ($p = 0.323$). The Mann-Whitney U tests revealed significant differences in pain scores, highlighting distinct impacts on postoperative pain. Comparing mean pain scores, the HARS technique appeared to result in slightly lower pain scores, indicating potentially better pain management. Complications were rare and managed conservatively in both techniques. Both HALS and HARS showed similar outcomes in terms of early bowel movement within 48 hours, with both techniques performing well.

Table I: Demographic and clinical characteristics of kidney donors.

Variables	Total (n = 358)	HALS (n = 130)	HARS (n = 228)	p-value
Age (years)		35.50 (16)	36 (15)	0.93
Donor-recipient relationship				
Brother	101	44 (33.8%)	57 (25.0%)	0.093
Sister	56	16 (12.3%)	40 (17.5%)	0.229
Father	24	8 (6.2%)	16 (7.0%)	0.782
Mother	39	9 (6.9%)	30 (13.2%)	0.074
Son	11	5 (3.8%)	6 (2.6%)	0.594
Husband	19	17 (13.1%)	2 (0.9%)	<0.001
Wife	46	13 (10.0%)	33 (14.5%)	0.278
Cousin	26	3 (2.3%)	23 (10.1%)	<0.001
Paternal Aunt	9	4 (3.1%)	5 (2.2%)	0.542
Maternal aunt	7	5 (3.8%)	2 (0.9%)	0.097
Nephew	9	4 (3.1%)	5 (2.2%)	0.542
Son-in-law	1	0 (0%)	1 (0.4%)	0.334
Brother-in-law	5	2 (1.5%)	3 (1.3%)	0.872
Sister-in-law	3	0 (0%)	3 (1.3%)	0.157
Paired donor	2	0 (0%)	2 (0.9%)	0.250
BMI (kg/m²)		27.02 (5)	24.48 (6)	<0.001
History of previous surgery				
No	308	106 (81.5%)	202 (88.6%)	0.065
LSCS Single	36	**14 (10.8%)**	**22 (9.6%)**	**0.710**
LSCS multiple	4	4 (3.1%)	0 (0%)	0.018
Bilateral tubal ligation	2	2 (1.5%)	0 (0%)	0.039
Appendectomy	2	2 (1.5%)	0 (0%)	0.039
Lap cholecystectomy	2	1 (0.8%)	1 (0.4%)	0.621
Dilation and curettage	1	1 (0.8%)	0 (0%)	0.144
Hysterectomy	2	0 (0%)	2 (0.9%)	0.250
Near total thyroidectomy	1	0 (0%)	1 (0.4%)	0.438
Preoperative albumin creatinine ratio (mg/gm)		4.58 (4.08)	4.42 (3.9)	0.709
Preoperative creatinine (mg/dL)		**0.76 (0.22)**	**0.72 (0.25)**	**0.201**
Preoperative creatinine clearance (ml/min)		115 (33.3)	115 (35.0)	0.899
eGFR on DTPA (ml/min)		105 (20)	106 (23)	0.718
Hep B core antigen				
Positive	40	8 (20%)	32 (80%)	0.02
Ebstein bar virus				
Positive	333	114 (34.2%)	219 (65.8%)	<0.001

Median (IQR), (Mann-Whitney U test). Frequencies are in absolute numbers along with percentages in brackets (Chi-square test).

Table II: Donors' intra- and postoperative data.

Variables	HALS	HARS	p-value
Kidney procured			
Right	5 (3.8%)	1 (0.4%)	0.016
Left	125 (96.2%)	227 (99.6%)	0.016
WIT in seconds	78.5 (38.5)	90 (33.5)	0.002
Operative time in minutes	165 (56)	155 (43)	0.20
Operative blood loss (ml)	100 (50)	100 (50)	0.41
Pain score 12 hours	6 (1)	3 (1)	<0.001
Pain score 24 hours	5 (2)	3 (1)	<0.001
Pain score 48 hours	2 (1)	1 (1)	<0.001
Pain score 10 days	0 (1)	0 (1)	0.03
Length of hospital stay	**3 (1)**	**2 (0)**	**<0.001**
Audible bowel sounds			
6 hours	0 (0.0%)	1 (0.4%)	-
12 hours	82 (63.1%)	218 (95.6%)	0.001
24 hours	47 (36.2%)	9 (3.9%)	<0.001
36 hours	1 (0.8%)	0 (0.0%)	-
Vomiting			
Yes	14 (60.9%)	9 (39.1%)	0.01

Median (IQR), (Mann-Whitney U test). Frequencies are in absolute numbers along with percentages in brackets (Chi-square test).

DISCUSSION

The analysis compared two distinct approaches for hand-assisted donor nephrectomy: The transabdominal approach and the retroperitoneal approach. Despite the absence of clear evidence favouring either technique, this study's findings demonstrate comparable donor outcomes following both procedures, however, kidneys recovered *via* the transperitoneal approach exhibited a significantly shorter overall WIT, despite similar OT for both methods. While the HARS approach showed a trend towards shorter OT, the HALS group required significantly more frequent use of laxatives, often accompanied by vomiting, indicating a greater impact on bowel function. Importantly, this study affirms the safety and feasibility of both left and right nephrectomies using surgical techniques.

The outcomes observed in this study corroborate with previous literature on live kidney donation surgeries. It is also aligned with existing research indicating that HALS and HARS

techniques offer safe and effective approaches for live kidney donation. The average BMI of donors and the predominance of female donors reflect trends reported in other studies, highlighting the consistency in donor demographics across different healthcare settings.[8,9] This study's findings regarding WIT, and the incidence of postoperative complications align with established benchmarks for live kidney donation surgeries. The minimal complications reported, predominantly categorised as Clavien Dindo Grade 1, indicate the overall safety and efficacy of both HALS and HARS techniques.[10-12] Postoperative donor complication rates range from 0 to more than 40% in different reports, depending on how authors classify adverse events after a nephrectomy.[13-15] This study analysis defined complications according to the Clavien-Dindo classification. The notable decrease in pain scores over the postoperative period, particularly with the HARS technique, is consistent with studies emphasising the importance of effective pain management strategies in live kidney donation surgeries.[16] The observed differences in pain scores and LOS between HALS and HARS techniques are in line with previous research highlighting variations in postoperative recovery trajectories. While this study suggests potential advantages of the HARS technique in terms of shorter OT, optimised WIT, early return of bowel function and lesser postoperative analgesia requirement, further investigation is warranted to elucidate the underlying mechanisms and long-term implications.[17] Future research endeavours should prioritise comparative effectiveness analyses and patient-centred outcomes to optimise surgical techniques and enhance donor experiences. Blood loss is a critical consideration in live kidney donation surgeries, impacting both donor safety and surgical outcomes. This study observed a median blood loss of HALS 100.00 ml (IQR: 100.00 ml), which is consistently close to the values in previous literature. The management of blood loss during live kidney donation procedures is multifaceted, involving meticulous surgical techniques, intraoperative monitoring, and postoperative care protocols.[18]

This study also showed that HARS has a shorter LOS, consistent with the trend observed in similar studies. Donors in the HARS group experienced quicker recovery and fewer complications, reflecting the advantages of HARS in postoperative recovery. This aligns with findings from other research, where HARS Donor Nephrectomy (HARDN) is associated with a reduced recovery time and fewer complications compared to HALS donor nephrectomy (HALDN). These results suggest that HARS may offer benefits in terms of quicker recovery and a shorter LOS due to its minimally invasive approach.[19]

The study benefited from a thorough evaluation by a multidisciplinary committee, ensuring comprehensive data assessment. With a substantial sample size of 358 donors and meticulous data collection from a dedicated transplant database, the study's findings are reliable. Standardised protocols and postoperative care reduced variability. However, the retrospective design introduces potential biases, and the single-centre setting may limit generalisability. The focus on short-term outcomes and lack of long-term follow-up data may affect the depth of analysis and the sustainability of the interventions.

CONCLUSION

This study suggests that HARS may offer advantages in terms of shorter LOS and better pain management post-surgery whereas HALS may offer advantages in terms of shorter WIT. Additionally, there were significant differences in the impact of these techniques on donor bowel function postoperatively, with HARS showing a more favourable outcome.

ETHICAL APPROVAL:
This study has been approved by the Institutional Review Board of Pakistan Kidney and Liver Institute and Research Centre, Lahore, Pakistan (Reference No: PKLI-IRB/AP/99).

PATIENTS' CONSENT:
Informed consent was waived as the study utilised anonymised medical records and posed minimal risk to patient privacy.

COMPETING INTEREST:
The authors declared no conflict of interest.

AUTHORS' CONTRIBUTION:
UF, AB, NM, FAT: Study concept and designing.
UF, ZUHA, AA: Data acquisition.
NM, FAT, ZUHA, AA: Analysis, interpretation of data for the work, drafting of the manuscript, and critical revision of the manuscript.
All authors approved the final version of the manuscript to be published.

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