

Five-year review of laparoscopic radical nephrectomies: initial experience with en bloc hilar ligation using an Endo GIA stapler

UE Oyibo,^{1,2}  J Lazarus¹ 

¹ Division of Urology, Groote Schuur Hospital, University of Cape Town, South Africa

² Urology Unit, Department of Surgery, Federal Medical Centre, Keffi, Nigeria

Corresponding author, email: ugbedeoyibo@gmail.com

Purpose: This study aimed to present the outcomes of patients undergoing laparoscopic radical nephrectomy (LRN) and hilar ligation with an endovascular gastrointestinal anastomosis (Endo GIA) stapler for malignant renal tumours.

Materials and methods: A retrospective review of patients who underwent LRN at Groote Schuur Hospital, Cape Town, between January 2018 and December 2022, focusing on those with renal cell carcinoma (RCC) and upper tract transitional cell carcinoma. Data on demographics, operative, and histopathological outcomes were collected.

Results: The final cohort consisted of 69 patients with a mean (standard deviation) age of 57.9 years (± 12.7), with 49.3% male (34 patients) and 50.7% female (35 patients). The most common presenting complaint was flank pain (49.3%). Of the patients, 29 (41.4%) were asymptomatic and diagnosed incidentally. Of the cohort, 23 (33.3%) were clinical tumour, node, and metastasis (TNM) stage III. All patients underwent LRN and hilar ligation using Endo GIA staplers, mostly performed via the transperitoneal approach. Most patients (63.7%) had no Clavien–Dindo grade complications, and a minority (16, 23.2%) developed complications. The median operating time was 221.58 minutes, with a mean (interquartile range) hospital stay of 5.8 days. The most common histopathological variation was clear-cell carcinoma in patients with RCC, consisting of 56.5%, and 20.3% of patients had transitional cell carcinoma (TCC). Most of the RCC had Fuhrman grade 2 (34.8%) and a negative surgical margin at resection (95.2%). The most common pathological stage of the disease was pT3, constituting 25 (38.5%).

Conclusion: The en bloc ligation of the renal hilum using an Endo GIA stapler is a practicable and advocated method that should be institutionalised.

Keywords: laparoscopic, ligation, nephrectomy, renal cell carcinoma, en bloc hilar

Introduction

Kidney tumours are the third most common cancer of the urogenital system and are analogous with the highest mortality. Their resistance to chemotherapy and radiotherapy makes surgery the standard mode of treatment. The surgery options are open, laparoscopic, or robotic.¹ The standard of care for localised renal cell carcinoma (RCC) not amenable to partial nephrectomy remains laparoscopic radical nephrectomy.²

The laparoscopic radical nephrectomy (LRN) procedure is frequently performed by reproducing the delicate steps of open surgery.³ Laparoscopic nephrectomy (LN) has advanced from the era of case reports to a standard procedure following the first account in humans by Clayman et al.⁴ in 1991, making it an established intervention for RCC.⁵ The long-term cancer control was similar to open procedures for post-infectious and other benign kidney disorders.^{6,7}

In developing countries, LN acquisition is impeded by equipment access and expertise scarcity. Many public hospitals in South Africa share similar experiences, as open nephrectomy remains the standard of care with its concomitant morbidity.⁸

This study aimed to evaluate the outcome of LRN, determine the demographics of patients receiving LRN, and report tumour characteristics and the technical challenges encountered using an endovascular gastrointestinal anastomosis (Endo GIA) stapler for en bloc hilar ligation in patients with RCC.

Indications for laparoscopic radical nephrectomy

The indications for LRN are often considered based on the tumour size alone; however, the clinical stage of the tumour is more important than the size because it encompasses the local extent of the tumour. A review of other centres' experiences revealed that clinical stage T1–2 renal tumours are amenable to LRN, with one of the institutions reporting a 13 cm renal tumour as the largest T2 renal tumour resected laparoscopically. The Gerota's fascia in stage T1–2 N0M0 renal tumours is intact, preventing the communication of the laparoscopic instruments with the tumour and decreasing the risk of tumour seeding. Limited data have elucidated the role of LRN for T3 tumours, which is often individualised for the patient.

The contraindications for LRN include patients who are not candidates for laparoscopy, patients with peritonitis, sepsis, extensive adhesions from multiple prior open surgical procedures, morbid obesity, severe cardiopulmonary disease, dilated bowel, large intra-abdominal mass, uncorrected coagulopathy, and/or hypovolaemic shock. Furthermore, patients with an active urinary infection should have sterile urine before the procedure.⁹

Control of the renal pedicle during laparoscopic radical nephrectomy

Control of the renal pedicle is a critical juncture in this surgery, with safety concerns prompting device advances for vessel ligation. The inability of the renal vessels to be quickly and accurately found and processed correctly during the operation predisposes to an

increased risk of pedicle injury, with resultant massive haemorrhage and open conversion.¹⁰ In the past, various devices were used to secure vessels, including intracorporeal knot-tying, bipolar vessel-sealing devices, LigaSure™ vessel seal, and harmonic scalpel during laparoscopic donor nephrectomy. However, these devices are only recommended for the ligation of the renal vessel tributaries.

Numerous devices are currently available for renal pedicle control, including non-absorbable polymer locking clips (Hem-o-lok clips), titanium clips, an Endo GIA stapler, an endovascular thoracic-abdominal (Endo TA) stapler, a laparoscopic LigaSure™ vessel seal, and others. These devices are broadly divided into two major groups: clips and staplers.

Various vascular control techniques and materials have evolved after the advent of metal clips in 1993.¹¹ The first device used to ligate renal vessels was the Endo GIA stapler, making it the tool for standard ligation. Its safety and effectiveness make it suitable for many LN procedures.^{12,13}

Materials and methods

Study design

This retrospective study included all patients who underwent LRN at the Division of Urology, Groote Schuur Hospital, Cape Town, between 1 January 2018 and 31 December 2022.

Study population and data source

The urology theatre/department computer database was searched for RCC to identify patients who underwent LRN during the study period. Folders of identified patients were retrieved from the medical records. A pre-tested, structured data collection form was used to extract information from patients' files, a picture archiving and communication system (PACS), and the National Health Laboratory Service track system (NHLS lab track). The information collected included demographics, preoperative imaging findings, operative information (laparoscopic approach, operative time, estimated blood loss, and transfusion requirements), and postoperative outcomes (histopathology findings, length of hospital stay, and complications).

Inclusion criteria

Patients with clinical T1 and T2 kidney tumours, no metastasis on preoperative imaging, no contraindications to laparoscopic surgery, adult patients who received en bloc ligation of the renal pedicle with an Endo GIA stapler, and all histologically confirmed cases of renal or upper tract cancer were included in the study.

Exclusion criteria

Patients with caval thrombus or vascular infiltration, contraindication to laparoscopic surgery, incomplete data to measure surgery outcome, insufficient details relating to the mode of ligation of the renal pedicle in their surgical record, and patients who had other forms of renal hilar ligation clips were excluded from the study.

Surgical technique

During the approach of the renal hilum, the gonadal vein was dissected and ligated at the level of the lower pole of the kidney to

allow for mobilisation of the ureter if warranted. The ureter was then traced as it extended into the renal pedicle from the lower pole of the kidney. This was necessary to allow for the manoeuvrability of the renal hilum and eventual dissection with sufficient space for safe ligation of the renal pedicle.

This method is like that of Conradie et al.,¹⁴ attempting to provide a safe triangular plane to facilitate the dissection of the hilum through the space between the gonadal vein and the ureter. We used the 45 mm and 60 mm Endo GIA stapler and 2.5 mm staples (Covidien, Dublin-Ireland) to ligate the renal vasculature. Visual identification of the polar arteries was performed during the intraoperative search, and subsequent ligation was performed separately using Hem-o-lok clips.

Table 1: Patient characteristics

	Mean	n (%)
Age (years)		
< 60		(37) 53.6
60–70		(19) 27.6
> 70		(13) 18.8
Mean age	57.9	
Gender		
Male		35 (50.7)
Female		34 (49.3)
BMI (kg/m²)		
< 25		17 (24.6)
25–30		19 (27.5)
> 30		26 (37.7)
NOS		7 (10.2)
Comorbidity		
Diabetes mellitus		15 (21.7)
Hypertension		47 (68.1)
Heart disease		19 (27.5)
COPD		9 (13.0)
Hypercholesterolemia		16 (23.2)
Asthma		4 (5.8)
Smoking status		
Current		44 (63.8)
Never		24 (34.8)
Unknown		1 (1.4)
Pack-years	29.2	
Family history of malignancy		
Yes		14 (20.3)
No		27 (39.3)
Not aware		28 (40.6)
Preoperative haemoglobin (g/dl)	12.37	
Preoperative creatinine (μmol/L)	94.79	
Mean drop in haemoglobin (g/dl)	1.66	

BMI – body mass index, COPD – chronic obstructive pulmonary disease
NOS – Not otherwise specified

Data management and analysis

Data were analysed using the Statistical Package for the Social Sciences version 23.0 (IBM SPSS Inc., Chicago, USA).

Results

Patient characteristics

During the study period, 69 patients underwent LN with an Endo GIA stapler for hilar ligation at the Groote Schuur Hospital, Cape Town. Table I summarises patient characteristics for LN and nephroureterectomy with an Endo GIA stapler for hilar ligation. Other clinical pathological parameters are presented in Table II.

Surgical approach

Table III summarises the breakdown of the surgical approaches. Of the patients, 11 intended to be treated laparoscopically went on to have conversion to open surgery (15.9% conversion rate). These

Table II: Other clinical pathological parameters

Parameter	n (%)
Coexisting stone	
Yes	6 (8.7)
No	63 (91.3)
Presentation	
Chief complaint	
Flank pain	34 (49.3)
Haematuria	28 (40.6)
Flank mass	10 (14.5)
Loss of weight	16 (23.1)
Incidental findings	
Yes	29 (41.4)
No	40 (58.6)
SSIGN score	
0–2	9 (14.5)
3–5	23 (37.1)
≥ 6	17 (27.4)
NA	13 (21.0)
Stage of disease	
I	20 (29.0)
II	16 (23.2)
III	23 (33.3)
IV	6 (8.7)
NOS	4 (5.8)

SSIGN – stage, size, grade, and necrosis NA-Not available NOS-Not otherwise specified

Table III: Breakdown of surgical approaches

	Laparoscopic	Laparoscopic converted to open	Total
Radical nephrectomy	45	9	54 (78.3%)
Radical nephroureterectomy	13	2	15 (21.7%)
Total	58 (84%)	11 (15.9%)	69 (100%)

patients all had renal masses larger than 6 cm, and the reasons for conversion were technical difficulty due to the size of the mass, bleeding, and injury to adjacent organs (inferior vena cava and liver).

Histopathological findings

Figure 1 illustrates the histopathological findings at LN. The malignant tumours included clear-cell carcinoma, papillary cancer, chromophobe cancer, oncocytoma, and urothelial cancer. Other malignant types identified included translocation-associated RCC, clear-cell eosinophilic variants, moderately differentiated non-keratinising squamous cell carcinoma, hybrid clear and papillary, metanephric nephroma, and eosinophilic variants of papillary RCC. The tumour characteristics for the 69 patients with RCC are described in Table IV.

Outcomes and complications

The perioperative outcomes and complication grading according to the modified Clavien–Dindo classification is summarised in Table V. Patient death is classified as grade V. The patient who died following laparoscopic nephroureterectomy (LNU) had ileus, a deteriorating level of consciousness, and cardiovascular compromise requiring inotropes on day eight postoperatively while in the ward.

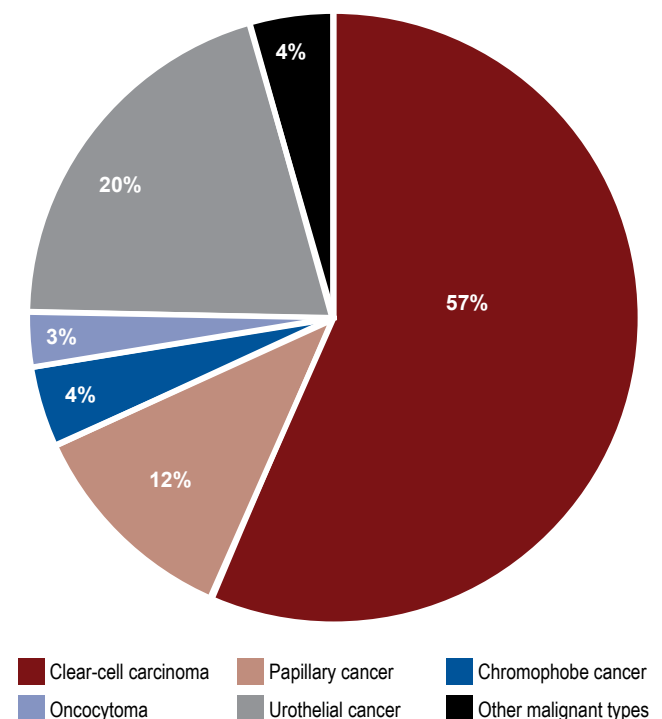


Figure 1: Distribution of histopathological findings at nephrectomy

Table IV: Renal cell carcinoma tumour characteristics

Parameters	Laparoscopic, n (%)
Median tumour size at histopathology (cm)	7
T stage	
T1a	9 (13.0)
T1b	5 (7.2)
T2a	10 (14.5)
T2b	5 (7.2)
T3a	20 (29.0)
T4	4 (5.8)
Not specified	16 (23.0)
N stage	
N0	18 (26.1)
N1	4 (5.8)
Nx	47 (68.1)
M stage	
M0	11 (15.9)
M1	2 (2.9)
Mx	50 (72.5)
Not specified	6 (8.7)
Fuhrman grade	
1	6 (8.7)
2	24 (34.8)
3	14 (20.3)
4	6 (8.7)
Not specified	19 (27.5)
Resection margins	
Negative	59 (95.2)
Positive	3 (4.8)
Not specified	0 (0)

Discussion

LRN and LNU for transitional cell carcinoma (TCC) are increasingly performed as effective methods of extirpative surgical interventions, preferred for being a minimally invasive option without compromising oncological outcomes.¹⁵ Human LN was first performed by Clayman et al.⁴ in 1990, attracting curiosity and modification in this technique to renal surgery. Since its inception, the widespread affirmation of a laparoscopic approach to nephrectomy has increased with several modifications and improvements in the urology fraternity. Its indications shifted from simple nephrectomy for benign tumours to radical nephrectomy and radical nephroureterectomy for malignant tumours. Compared to open techniques for renal surgery, the main advantages of the laparoscopic technique are its reduced pain and loss of blood, enhanced return to normal activity, and superb cosmetic results.^{16,17} The decreased morbidity and expedited recovery associated with LN, without downplaying oncological efficacy, remains an added advantage, as reported by Gill et al.¹⁸

Table V: Intra- and postoperative outcomes

Parameter	n (%)
Affected kidney	
Left	33 (47.8)
Right	36 (52.2)
Mean operative time (minutes)	216
Mean estimated blood loss in theatre (ml)	402
Number of patients transfused (n [%])	7 (10.1)
Mean hospital length of stay (days)	5.7
Modified Clavien–Dindo complications	
None	44 (63.7)
I	14 (20.3)
II	2 (2.9)
III	2 (2.9)
IIIa	2 (2.9)
IIIb	3 (4.3)
IV	1 (1.5)
V	1 (1.5)
Specific postoperative complications	
Post-infection urosepsis, wound sepsis	8 (11.6)
Prolonged analgesia	13 (18.9)
Intraoperative complications	
Vascular Injury	9 (13.0)
Bowel injury	9 (13.0)
Port site morbidity	4 (5.8)

This data aims to describe the practical suitability of LN in a referral hospital using the Endo GIA stapler for en bloc hilar ligation over five years. The mean age in this study was 57.9 years, with most patients in the bracket of less than 60 years (53.6%), similar to other studies from Israel, which had a mean age of 58.3 years.¹⁸ It is noteworthy that a similar study by Singh et al.,¹⁹ from the KwaZulu-Natal Province, South Africa, reported a mean age of 45.3 years; ours is much higher due to the availability of specialists and skilled supporting surgical, anaesthetic/intensive care unit and oncology staff. The near-equal ratio of females to males, though marginally more females than males, is not surprising as it is similar to the study by Singh et al.¹⁹ However, this is not unexplainable as the major risk factor is similar in both sexes in our study population regarding smoking.²⁰

The association of comorbidities and RCC is well noted, with 68.1% of the patients diagnosed with hypertension. However, in a similar study by Colt et al.,²¹ they noted that the prevalence of hypertension in both men and women was higher among people of African descent, explaining the prevalence of hypertension in this predominantly African population.

In our study population, the masses were more common on the right, similar to a study by Mohamed et al.²² from Somalia who observed a predominance on the right side constituting 57%. However, ours was slightly similar to the occurrences on the left side.

The histological findings following nephrectomy revealed that 90.9% of the RCC subtypes were clear-cell, papillary, and chromophobe. Clear-cell and papillary RCC constituted 70.9% and 14.5%, respectively, with the former being the most aggressive and the latter having a better survival potential than the former. Chromophobe constituted 5% of the RCC, which has the best prognostic rate, and only 7% of cases were likely to metastasise.²³ The findings from our study were similar to a study from Somalia.²² Our study group showed clear-cell RCC as the most common histological variant, followed by papillary RCC.

The Clavien–Dindo criterion to assess postoperative complications, including urological produces, accurately and comprehensively has been applicable over the years.²⁴ In this study, the Clavien–Dindo criterion assessment of 69 patients who underwent LRN revealed no complications in 63.7%, minor complications in 23.2%, and major complications in 13.1%, constituting 10.1% (grade III), 1.5% (grade IV), and 1.5% (grade V). Minor complications included emesis, electrolyte derangement, chest infection, surgical site infections, blood transfusion, urosepsis, urinary tract infection, and postoperative ileus necessitating total parenteral nutrition. Major complications included pulmonary embolism, acute respiratory distress syndrome, right posterior cerebral artery stroke requiring right artery embolisation, upper gastrointestinal bleeding necessitating gastroscopy (G-scope), and death in one of the patients due to sudden intraoperative cardiovascular decompensation requiring inotropes intraoperatively and postoperatively.

Most of our patients had a good perioperative outcome and recovery at discharge, possibly because most patients were tumour, node, and metastasis (TNM) stage I (20, 29.0%) or III (23, 33.3%). Previous studies have shown that TNM staging is the best predictor of short and long-term prognosis and has necessitated the major guidelines towards subsequent management.²⁵ The patients' outcomes in this study are encouraging due to the multidisciplinary team approach and the availability of skilled and committed healthcare staff with timely imaging to review and follow-up recurrence.

In our study, a significant number of patients (29, 41.4%) were incidentally diagnosed, much higher than studies by Adem et al.,²⁶ from Ethiopia, constituting 13%. In developed countries, the numbers may be as high as 50% when patients undergo clinically indicated imaging for an unrelated complaint.^{27,28,29} A study by Pandey et al.²⁹ reported a rate of 42% incidentally detected tumours, which was much higher than previously reported. The relatively high proportion of patients who present with incidental diagnosis supports the role of screening in the early detection of RCC and the need for collaboration with other healthcare facilities focused on diagnosis and appropriate patient care.²⁸ Furthermore, these extrapolations strengthen the role of thorough and detailed evaluation and the need for in-depth reports of patients undergoing abdominal imaging for any indication, no matter how trivial.

Limitations

The extent and quality of the data collected were limited by the study's retrospective nature and the dependence on patient records. The nature of our centre as a single centre experience limits the

generalisability of our findings. Another limitation is the potential for arteriovenous fistula formation and the inability to exclude its occurrence due to the insufficient length of time for follow-up.

Conclusion

The en bloc ligation of the renal hilum using an Endo GIA stapler is a practicable and advocated method that should be institutionalised. Most complications were graded as modified Clavien–Dindo grade I.

Acknowledgements

The authors would like to acknowledge KARL STORZ Endoskope, Germany, for sponsoring Dr. Oyibo Ugbede Emmanuel for the KARL STORZ endourology fellowship training at the Groote Schuur Hospital/University of Cape Town, during which period the study was conducted. Special thanks to Dr. Orgeness Mbwapo, Ms. Sheene Isaac, Mr. Gary (records at E26), and Dr. Adamu Yahaya (Medical director, Federal Medical Centre, Keffi, Nasarawa State).

Conflict of interest

The researchers declare no conflict of interest or inducement from any company or manufacturer of consumables used in this study.

Funding source

2023 Endourology scholarship from Karl Storz Endoskope, Germany for fellowship at Groote Schuur Hospital/University of Cape Town, South Africa.

Ethical approval

Ethical clearance for this study was obtained from the Health Research and Ethics Committee of the Faculty of Health Sciences, University of Cape Town (HREC REF-518/2023).

ORCID

UE Oyibo  <https://orcid.org/0000-0002-4470-2587>

J Lazarus  <https://orcid.org/0000-0003-2417-8332>

References

1. Yikilmaz TN, Öztürk E, Güven MD, Hamidi N, Başar H. Vascular ligation in laparoscopic radical nephrectomy: comparison of the Endo GIA stapler and Hem-o-lok polymer clips. *Bull Urooncol*. 2018;17(4):124-6. <https://doi.org/10.4274/uob.1003>.
2. uroweb.org [Internet]. EAU guidelines on renal cell carcinoma. European Association of Urology; 2000 [updated 2024]. Available from: <https://uroweb.org/guideline/renal-cell-carcinoma/#3>. Accessed 3 December 2023.
3. Jindal T, Mukherjee S, Koju R, Nitesh S, Phom D. Simplifying laparoscopic nephrectomy for beginners: double window technique with en bloc hilar stapling. *Cureus*. 2021;13(7):e16090. <https://doi.org/10.7759/cureus.16090>.
4. Clayman RV, Kavoussi LR, Soper NJ, et al. Laparoscopic nephrectomy: initial case report. *J Urol*. 1991;146(2):278-82. [https://doi.org/10.1016/S0022-5347\(17\)37770-4](https://doi.org/10.1016/S0022-5347(17)37770-4).
5. Ono Y, Kinukawa T, Hattori R, et al. Laparoscopic radical nephrectomy for renal cell carcinoma: a five-year experience. *Urology*. 1999;53(2):280-6. [https://doi.org/10.1016/S0090-4295\(98\)00505-6](https://doi.org/10.1016/S0090-4295(98)00505-6).
6. Saika T, Ono Y, Hattori R, et al. Long-term outcome of laparoscopic radical nephrectomy for pathologic T1 renal cell carcinoma. *Urology*. 2003;62(6):1018-23. <https://doi.org/10.1016/j.urol.2003.07.009>.
7. Traxer O, Pearle MS. Laparoscopic nephrectomy for benign disease. *Semin La parosc Surg*. 2000;7(3):176-84. <https://doi.org/10.1177/15533506000700305>.
8. Singh A, Urry RJ, Hardcastle TC. Five-year review of open radical nephrectomies at a regional hospital in South Africa: room for improvement. *S Afr J Surg*. 2018;56(1):35-9.
9. Lau WY, Leow CK, Li AK. History of endoscopic and laparoscopic surgery. *World J Surg*. 1997;7(4):444-53. <https://doi.org/10.1007/PL00012268>.
10. Rosin D. Minimal access medicine and surgery: principles and techniques. Oxford: Radcliffe Medical Press; 1993. p. 1-9.
11. Cabello R, García JV, Quicios C, Bueno G, González C. Is there a new alternative for a safer kidney artery ligation in laparoscopic donor nephrectomy? *J*

- Laparoendosc Adv Surg Tech. 2017;27(7):715-6. <https://doi.org/10.1089/lap.2016.0271>.
12. Devra AK, Patel S, Shah SA. Laparoscopic right donor nephrectomy: Endo TA stapler is safe and effective. *Saudi J Kidney Dis Transpl.* 2010;21(3):421-5.
13. Ko EY, Castle EP, Desai PJ, et al. Utility of the endovascular stapler for right-sided laparoscopic donor nephrectomy: a 7-year experience at Mayo Clinic. *J Am Coll Surg.* 2008;207(6):896-903. <https://doi.org/10.1016/j.jamcollsurg.2008.07.013>.
14. Conradie MC, Urry RJ, Naidoo D, et al. Advantages of en bloc hilar ligation during laparoscopic extirpative renal surgery. *J Endourol.* 2009;23(9):1503-7. <https://doi.org/10.1089/end.2009.0380>.
15. Rassweiler JJ, Schulze M, Marrero R, et al. Laparoscopic nephroureterectomy for upper urinary tract transitional cell carcinoma: is it better than open surgery? *Eur Urol.* 2004;46(6):690-7. <https://doi.org/10.1016/j.eururo.2004.08.006>.
16. Dunn MD, Portis AJ, Shalhav AL, et al. Laparoscopic versus open radical nephrectomy: a 9-year experience. *J Urol.* 2000;164(4):1153-9. <https://doi.org/10.1016/j.juro.2006.10.053>.
17. Flowers JL, Jacobs S, Cho E, et al. Comparison of open and laparoscopic live donor nephrectomy. *Ann Surg.* 1997;226(4):483-9. <https://doi.org/10.1097/00000658-199710000-00009>.
18. Gill IS, Schweitzer D, Hobart MG, et al. Retroperitoneal laparoscopic radical nephrectomy: the Cleveland clinic experience. *J Urol.* 2000;163(6):1665-70. [https://doi.org/10.1016/S0022-5347\(05\)67516-7](https://doi.org/10.1016/S0022-5347(05)67516-7).
19. Singh A, Urry R. Laparoscopic versus open nephrectomy in resource-constrained developing world hospitals: a retrospective analysis. *Afr J Urol.* 2020;26(85). <https://doi.org/10.1186/s12301-020-00096-9>.
20. Fernander AF, Flisher AJ, King G, et al. Gender differences in depression and smoking among youth in Cape Town, South Africa. *Ethn Dis.* 2006;16(1):41-50.
21. Colt JS, Schwartz K, Graubard BI, et al. Hypertension and risk of renal cell carcinoma among white and black Americans. *Epidemiology.* 2011;22(6):797-804. <https://doi.org/10.1097/EDE.0b013e3182300720>.
22. Mohamed AH, Abdullahi IM, Eraslan A, Mohamud HA, Gur M. Epidemiological and histopathological characteristics of renal cell carcinoma in Somalia. *Cancer Manag Res.* 2022;14:1837-44. <https://doi.org/10.2147/CMAR.S361765>.
23. Padala SA, Barsouk A, Thandra KC, et al. Epidemiology of renal cell carcinoma. *World J Oncol.* 2020;11(3):79-87. <https://doi.org/10.14740/wjon1279>.
24. Kierstan A, Konecki T, Jablonowski Z. Assessment of complications after laparoscopic surgery of kidney tumors using Clavien-Dindo classification. *Pol Przegl Chir.* 2020;92(4):7-11. <https://doi.org/10.5604/01.3001.0014.1131>.
25. Lam JS, Klatte T, Breda A. Staging of renal cell carcinoma: current concepts. *Indian J Urol.* 2009;25(4):446-54. <https://doi.org/10.4103/0970-1591.57906>.
26. Adem RY, Hassen SM, Abdulaziz M, Ahmed AI, Jemberie AM, Gebeyehu YT, et al. Clinical Profile and Outcome of Patients Operated on for Renal Cell Carcinoma: Experience from a Tertiary Care Center in a Developing Country. *Res Rep Urol.* 2022;14:389-97. <https://doi.org/10.2147/RRU.S376720>.
27. Sun M, Thuret R, Abdollah F, et al. Age-adjusted incidence, mortality, and survival rates of stage-specific renal cell carcinoma in North America: a trend analysis. *Eur Urol.* 2011;59(1):135-41. <https://doi.org/10.1016/j.eururo.2010.10.029>.
28. Hollingsworth JM, Miller DC, Daignault S, Hollenbeck BK. Rising incidence of small renal masses: a need to reassess treatment effect. *J Natl Cancer Inst.* 2006;98(18):1331-4. <https://doi.org/10.1093/jnci/djj362>.
29. Pandey A, Mandal S, Das MK, Nayak P. Laparoscopic radical nephrectomy in the current era: technical difficulties, troubleshoots, a guide to the apprentice, and the current learning curve. *South Asian J Cancer.* 2022;12(2):141-7. <https://doi.org/10.1055/s-0042-1750185>.