

Trends in the surgical management of renal cell carcinoma in a contemporary tertiary care setting

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Abstract

Background: In the last three eras, the incidence of renal cell carcinoma (RCC) has increased, due to increased radiological studies. The expected 5-year survival rate has become better, associated with the identification of small size renal masses. However, this survival improvement may be secondary to improved surgical techniques and medical therapies for these malignancies.

Objectives: The objective was to report the trends of clinical presentation, peri-operative, oncological outcomes, and surgical management trends for RCCs over the period.

Methods: After Institutional Review Board approval, a retrospective study for adult patients was conducted, who presented with renal mass and were managed between 2008 and 2019. Variables, including demographics, perioperative and pathological outcomes analyzed using descriptive statistics for continuous variables reported as mean \pm standard deviation and categorical variables values compared by Chi-square test. Survival Analysis calculated using the Kaplan-Meier method. The level of significance is set at P-value < 0.05 .

Results: A total of 588 patients underwent surgical treatment for kidney cancer from January 2008 to January 2019. 237 (40.30%) were females and 351 (59.69%) males. The clinical presentation was higher as an incidental diagnosis of 58.67%. 71.25% of patients were from outside Riyadh city. Pathology was mostly clear cell RCC 61.22% and grade 2 (57.48%). Tumor size, surgery time, and length of hospital stay showed a significant difference between the three periods (both $P > 0.05$). Robotic surgery performed more than open ($P < 0.0001$). There was no significant difference in the survival time, when compared to patients by the regions and when compared by the primary tumors (Log-Rank $P = 0.4821$). Patients from the Riyadh region (median = 54.0) had a significantly higher recurrence time (Log-Rank $P < 0.0001$).

Conclusion: There was a rising trend in the incidence of RCC associated with comorbidities and incidental diagnosis. In our study period we found increase in the trend of minimal invasive approach. The size of the tumor, blood loss and operative time decreases over the period of time. The Robotic assisted nephrectomy approach has become increased over the period of time duration in present study.

Keywords: Laparoscopic, nephrectomy, renal cell carcinoma, robotic

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INTRODUCTION

Renal cell carcinoma (RCC) is one of the most common cancers of the kidney affecting more in male adults than females (>60,000 new cases/year, lifetime risk approximately 1.6%, with RCC, comprises approximately 9 of 10 kidney cancers.^[1] Recently it has been observed that the incidence rate of kidney cancer is increased due to incidentally findings on routine radiological imaging studies for other reasons of clinical presentation and most of these patients are diagnosed between the age of 55 and 74.^[2,3] The estimated data of the incidence in the United States have shown an increase by 2%.^[4] In Saudi Arabia, the cancer registry reported that kidney cancer has an age-standardized rate of 2.4/100,000, accounting for 2.3% of all cancers. The incidence has been increased by 33%, with most cases presenting late in the disease course. However, there are currently no national cancer programs aimed at early detection and prevention.^[5] The increased incidence of small renal masses has led to an expected evolution in the treatment of RCC. Minimally invasive techniques for the treatment of RCC have expanded extensive attractiveness, and now these methods to RCCs have exceeded open techniques in the rate of application. Laparoscopic and robotic-assisted techniques have now been applied to both radical and partial nephrectomy procedures of varying complexity. The early detection and treatment have been transformed very fast. Although the incidence of RCC has been increasing, the survival rate becomes better. Recently, the trends of minimally invasive surgery, laparoscopic or robot-assisted nephron-sparing surgical techniques has increased, as small size tumors are being diagnosed incidentally.^[4,6-8] The different surgical methods are currently available in urological surgery: open, laparoscopic, or robotic. The techniques depend on the size of the tumor according to the guidelines. Nephron sparing surgery is favored for the T1 category (≤ 7 cm) cases.^[9-11] All patients with clinical stage T1 should council for a minimally invasive approach (laparoscopic or robotic).^[12] This study aims to report the descriptive analysis of patient demographics, mode of clinical presentation, peri-operative, and oncological outcomes. To investigate and compare the trends of different surgical approaches from open to Laparoscopic or robotic-assisted for RCC in a contemporary tertiary care setting.

METHODS

After approval from the Institutional Review Board, retrospectively we reviewed the electronic records of all adult patients (>18 years) who present with primary kidney tumors and underwent surgery at our center

between 2008 and 2019. Patients' demographic profiles were studied including variables (age, sex, place of origin, comorbidities, cigarette smoking history, the pattern of clinical presentation, laterality, and staging on computerized tomography scan (CT scan). Pathological outcomes and tumor characteristics feature also reviewed. Detailed operative notes were reviewed for different variables, including blood loss, intraoperative complication, surgery time, and type of surgical approach (open, laparoscopic, or robotic). During the study period, 585 patients were treated by different surgical approaches. Further, we review analyzed the different techniques (open partial nephrectomy [OPN], open radical nephrectomy [ORN], laparoscopic partial nephrectomy (LPN), laparoscopic radical nephrectomy (LRN), robotic partial nephrectomy (RPN), and robotic radical nephrectomy (RRN). We split this period of study into three cohorts of equally 4 years, to compare the perioperative and surgical approach outcomes. Cohort 1 (January 2008–December 2011), Cohort 2 (January 2012–December 2015), and Cohort 3 (January 2016–December 2019). Our inclusion criteria were the cases of RCC from 2008-2019 were included for review in this study and those patients who were suffering from other chronic medical conditions were excluded from the study. For this retrospective study, all statistical analyses of data were done using the SAS software package, version 9.4 (Statistical Analysis System, SAS Institute Inc., Cary, NC, USA). Descriptive statistics for continuous variables were reported as mean \pm standard deviation and categorical variables summarized as frequencies and percentages. Continuous variables were compared by independent Student's *t*-test/analysis of variance or nonparametric (Mann–Whitney *U*-test/Kruskal–Wallis) test as appropriate, while categorical variables were compared by Chi-square test. Survival Analysis will be calculated using the Kaplan–Meier method. The level of significance is set at a $P < 0.05$. All complications were noted according to the Clavien–Dindo grading system.^[13]

RESULTS

Out of six hundred and eight patients, twenty patients were excluded due to concomitant other organ surgery, loss of follow up, or missing data. Five hundred and eighty-eight adult patients (aged >18 years) were included, those who underwent surgery for RCC with different surgical techniques. The patient's demographic profile and clinical presentation are shown in Table 1. 237 (40.30%) were females and 351 (59.69%) were males. Majority of the patients 71.25% were originated from outside Riyadh city. 45.06% and 35.37% were overweight and obese with body mass index (BMI) >30, respectively. The mean age of the

patients was mean \pm standard deviation (SD) (54.0 ± 16.5) and the mean BMI was 25.8 ± 4.3 . The mode of clinical presentation was identified more in asymptomatic patients or incidental findings in 345 (58.67%) patients on radiological imaging study for other indications. In our study mostly comorbidities were Hypertension and Diabetes Mellitus in 32.14% and 35.71% respectively. 54.93% of patients were staged clinically as T1, followed by T2 (22.44%) [Table 1]. The study period from 2008 to 2019 was divided into three periods of equally 4 years. Table 2 displays a comparison of peri-operative details between three periods of time. There was no significant

Table 1: Patient's demographic profile and clinical presentation (n=588)

Variables	Frequency (%)
Gender	
Male	351 (59.69)
Female	237 (40.30)
Region	
Riyadh	169 (28.74)
Outside	419 (71.25)
Smoking	222 (37.75)
Weight	
Normal	115 (19.55)
Overweight	265 (45.06)
Obese (BMI >30)	208 (35.37)
Laterality	
Left	301 (51.19)
Right	287 (48.80)
Clinical presentation	
Microscopic hematuria	75 (12.75)
Abdominal pain	168 (28.57)
Incidental findings	345 (58.67)
ASA score	
1	56 (9.52)
2	349 (59.35)
3	173 (29.42)
4	10 (1.70)
Diabetes mellitus	210 (35.71)
Hypertension	189 (32.14)
Chronic kidney disease	58 (9.86)
Other	88 (14.96)
Missing data	43 (7.31)
Clinical stage	
cT1a	169 (28.74)
cT1b	154 (26.1)
cT2	132 (22.44)
cT3a	90 (15.30)
cT3b-cT3c	39 (6.63)
cT4	4 (0.68)

BMI: Body mass index, ASA: American Society of Anesthesiologists

Table 2: Peri-operative details (n=588)

Variables	2008-2011	2012-2015	2016-2019	P
Age, mean \pm SD	54.27 \pm 14.63	51.2 \pm 15.33	50.28 \pm 17.99	0.0635
Tumor size, mean \pm SD	7.32 \pm 4	6.44 \pm 4.42	6.28 \pm 3.63	0.0452
Estimated blood loss (ml), mean \pm SD	334.16 \pm 472.31	316.47 \pm 404.23	279.89 \pm 373	0.4808
Surgery time (min), mean \pm SD	160.47 \pm 74.19	138.87 \pm 62.84	130.94 \pm 40.93	<0.0001
Length of stay (days), mean \pm SD	12.0 \pm 2.0	7.0 \pm 1.0	4.0 \pm 1.0	<0.001
Complications (grade 1-2), n (%)	38 (6.46)	27 (4.59)	25 (4.25)	-
Complications (grade 3-4), n (%)	14 (2.38)	11 (1.87)	8 (1.36)	-
Follow-up (months) mean \pm SD	119.0 \pm 16.0	49.0 \pm 20.0	15.0 \pm 8.0	<0.001

Clavien-Dindo grading classification. SD: Standard deviation

difference between the age and the estimated blood loss for the patients. However, Tumor size, surgery time, and length of hospital stay showed a significant difference between the three periods (both $P > 0.05$). The overall complication rate was grade 1-2 in 15.30% and grade 2-3 in 5.61%. Different surgical approaches were compared to determine the trends in surgical techniques. Three-time periods [Table 3] were reviewed and outcomes show Robotic surgeries performed significantly increased throughout the years while open surgeries decreased ($P < 0.0001$). Graph 1 and Table 4 show the changes in surgical trends from open to minimally invasive surgeries. Robotic Radical (RRN) and Robotic Partial (RPN) have been significantly performed more than Open Radical (ORN) and Open Partial (OPN) ($P < 0.0001$). Graph 2 and Table 5 show the pathological outcomes and tumor characteristics feature. Mostly histopathological type of RCC was Clear cell RCC (61.22%), followed by papillary and chromophobe RCC. The pathological T stage was reported as pT1 (pT1a and pT1b) in 55.96%. The nuclear Fuhrman grade was identified mainly as grade 2 in 57.48%. We also review and analyzed the survival time in patients from Riyadh city and outside Riyadh. and mean follow up was 54.5 ± 14.2 . There was no significant difference in the survival time (Log-Rank $P = 0.5124$) when we compare patients by the regions. There was no significant difference in the survival time (Log-Rank $P = 0.4821$) when we compare patients by the primary tumors [Graph 3]. Patients in the Riyadh region (median = 54.0) had a significantly higher recurrence time (Log-Rank $P < 0.0001$) than patients in other regions. Patients with the pT2 Primary Tumor (median = 70.0) had a significantly higher recurrence time (Log-Rank $P \text{ value} < .0001$) than patients with other Primary Tumors (pT) [Graph 4].

DISCUSSION

The current study of RCC reported the outcomes of epidemiology factors (risk factors and mode of clinical presentation), Trends in the surgical approach from open versus robotic-assisted nephrectomy, perioperative, and pathological outcomes.

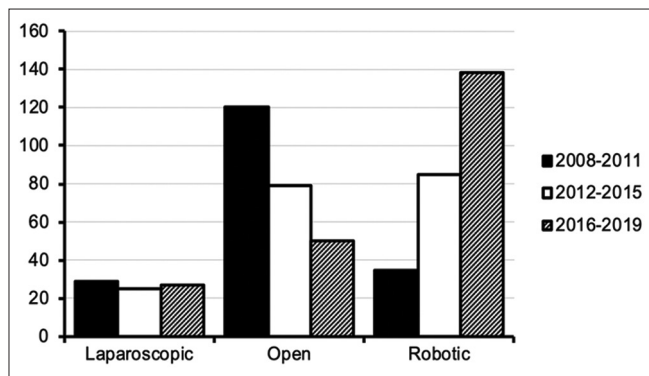
Table 3: Change in surgical trends from open to minimal invasive (n=588)

Frequency percent	Open (%)	Laparoscopic (%)	Robotic (%)	Total (%)	P
2008-2011	120/184 (65.21)	29/184 (15.76)	35/184 (19.02)	184/585 (31.45)	<0.0001
2012-2015	79/189 (41.79)	25/189 (13.22)	85/189 (44.97)	189/585 (32.30)	
2016-2019	50/215 (23.25)	27/215 (12.58)	138/215 (64.18)	215/585 (36.75)	
Total	249/585 (42.56)	81/585 (13.84)	258/585 (44.10)	588 (100.00)	

Table 4: Analysis of different surgical types performed in three periods (n=588)

Period	ORN, n (%)	OPN, n (%)	LRN, n (%)	LPN, n (%)	RRN, n (%)	RPN, n (%)	P
2008-2011	89/184 (48.36)	31/184 (16.84)	19/184 (10.32)	10/184 (5.43)	18/184 (9.78)	17/184 (9.23)	<0.0001
2012-2015	34/189 (17.98)	45/189 (23.89)	11/189 (5.82)	14/189 (7.40)	51/189 (26.98)	34/189 (17.98)	
2016-2019	19/258 (7.36)	31/258 (12.01)	12/258 (4.65)	15/258 (5.81)	60/258 (23.25)	78/258 (30.23)	

OPN: Open partial nephrectomy, ORN: Open radical nephrectomy, LPN: Laparoscopic partial nephrectomy, LRN: Laparoscopic radical nephrectomy, RPN: Robotic partial nephrectomy, RRN: Robotic radical nephrectomy



Graph 1: Analysis of different surgical types performed in three periods (n = 588)

Epidemiology/risk factors

In our study from Saudi Arabia at a tertiary care center, 59.69% of patients were male and 40.30% were female. We observed that mostly 71.25% of patients were referred to our hospital from outside Riyadh capital city of Saudi Arabia. We identified that 345 (58.67%) patients reported as asymptomatic, were diagnosed incidentally on radiological imaging studies for other reasons. Nearly 80% of patients were overweight or obese and other notifiable risk factors were Hypertensive patients on medications, Diabetes Mellitus on oral hypoglycemic drugs or insulin therapy, and cigarette smoking in 32.14%, 35.71%, and 37.75% respectively. One of the studies recently published by Alkhateeb *et al.*^[14] from Saudi Arabia and they published the 25 years’ experience at a tertiary care center, reported that there is an increasing trend in the incidence of kidney cancer associated with certain risk factors. Risk factors outcome were Diabetes Mellitus, Hypertension, dyslipidemia, and cigarette smoking, obesity, overweight in 53.2%, 46.2%, 39.1%, 25%, 42.3%, and 30% respectively.^[14] Hypertension was the most common comorbidity, followed by diabetes mellitus. In our study, the comorbidities were identified more with hypertension and diabetes mellitus. Another study of 215 patients reported by the same author that the incidence of kidney cancer has been increased

over the last 2 decades.^[15] And authors reported that most of the patients were hypertensive at the time of diagnosis 31.1% in the 3rd quartile and 53.1% in the 4th quartile, statistically significantly different from the initial years of study. Published data from North America, Europe, and Asia have also reported there is an increasing incidence in RCC.^[16,17] This trend may be linked to the increased incidence of comorbidities of hypertension, diabetes mellitus, smoking, and obesity in Saudi Arabia.^[18,19]

Obesity is a recognized risk factor for kidney cancer. However, many studies and one meta-analysis of 20 studies have proved the RCCs occurring in obese patients are linked with a lower stage and a grade at initial clinical presentation and thus may be associated with improved cancer-specific survival in a population with localized RCC.^[20-23] Recently it has been identified that radiological studies are conducting more so that the detection of small renal masses becomes more.^[24,25] In our study the majority of patients 54.93% were diagnosed as clinical T1 stage and 22.44% as T2 stage. In a meta-analysis, by Rossi *et al.*^[26] the incidental presentations were stage 1 and 2.

Trends in the surgical approach

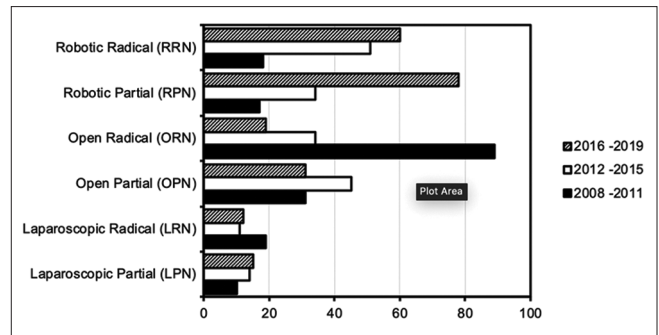
Our study shows a rapid and favorable evolution in surgical management for RCC. There was a significant change in the trends from open to minimally invasive approaches, especially the robotic approach. In the initial period of 2009–2011, the open approach was used more as compared to laparoscopic or robotic. Open >Robotic >Laparoscopic 65%, 19% and 16% respectively. In the mid-period of the study from 2012–2015 the trend has been changed toward the robotic approach, Robotic >Open >laparoscopic 45%, 41%, and 14% respectively. The last period of the study revealed significant progress toward robotic. Robotic >open >Laparoscopic 64%, 23% and 13% respectively with P <0.0001 [Table 3]. Further, we compared the different surgical techniques in three groups of study. Recently it has shown that the surgical management of renal masses has experienced a speedy progression in

Table 5: Pathological outcomes and tumor characteristics features

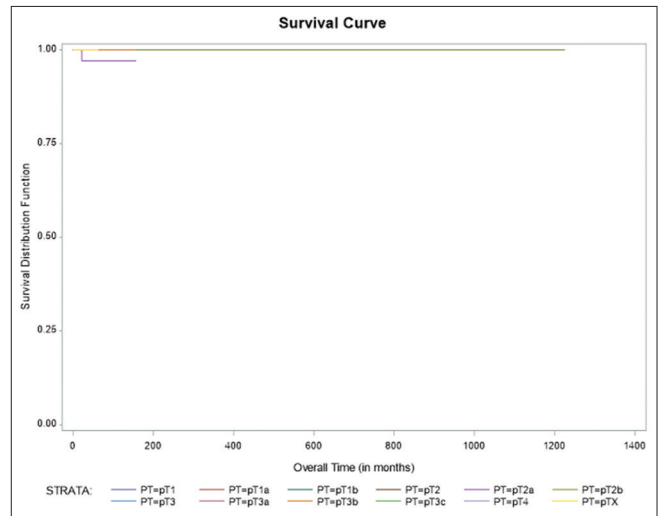
Variables	Frequency (%)
Histopathology types	
Clear cell renal cell carcinoma	360 (61.22)
Nonclear cell renal carcinoma	
Papillary renal cell carcinoma	60 (10.20)
Chromophobe renal cell carcinoma	62 (10.54)
Oncocytoma	36 (6.12)
Carcinoma of the collecting ducts of Bellini	2 (0.34)
Translocation carcinoma (Xp11 or others)	6 (1.20)
Carcinoma associated with neuroblastoma	1 (0.17)
Mucinous tubular and spindle cell carcinoma	5 (0.85)
Multilocular clear cell renal cell carcinoma	5 (0.85)
Tubulocystic renal cell carcinoma	2 (0.24)
Renal cell carcinoma, unclassified	7 (2.09)
Other benign (AML)	42 (7.14)
pT	
pT1a	171 (29.08)
pT1b	158 (26.87)
pT2	127 (21.59)
pT3a	83 (14.11)
pT3b-pT3c	45 (7.65)
pT4	4 (0.68)
Fuhrman nuclear grade	
Grade 1	35 (5.95)
Grade 2	338 (57.48)
Grade 3	166 (28.23)
Grade 4	49 (8.33)
Tumor focality	
Unifocal	508 (86.39)
Multifocal	80 (13.60)
Tumor necrosis	
Not identified	412 (70.43)
Present	176 (29.93)
Sarcomatoid features	
Not identified	527 (89.62)
Present	61 (10.37)
Regional lymph nodes (pN)	
pNX	436 (74.14)
pN0	113 (19.21)
pN1	39 (3.91)
Distant metastasis (pM)	
pM0	561 (93.70)
pM1	37 (6.29)
Positive surgical margins	
Status	53 (9.01)
Alive	
Mortality	58 (9.86)
Recurrence	
No recurrence	470 (79.93)
Recurrence	118 (20.06)

pT: Primary tumor, AML: Angiomyolipoma

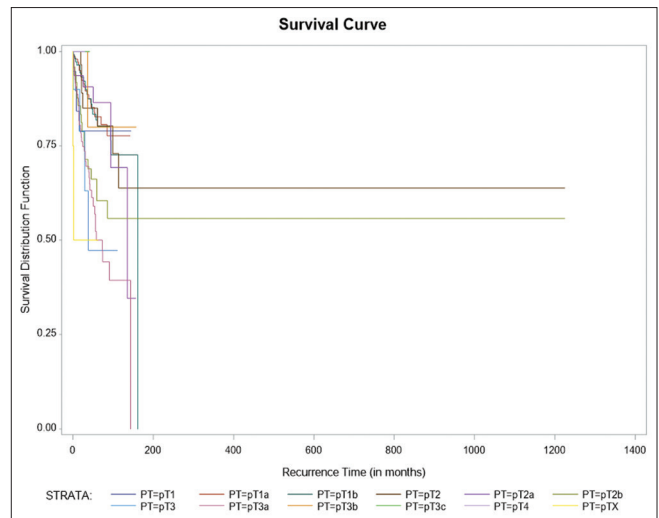
clinical practice during the past two decades.^[27] Milan Hora *et al.*^[28] reported in their study that in 2002, 2/3 of all cases were treated with ORN and 1/3 with open resection. However, in 2015–2016, the ratio of resections increased from 1/3 to up to 60% of cases due to updated guidelines revealed the indications from category T1a only (tumor ≤4 cm) to T1b (>4 cm and ≤7 cm) and even T2a (>7 cm and ≤10 cm) as well,^[9] improved laparoscopic resection technique^[29] enhanced methodological tools and a change of diagnosis to fewer innovative cases (growing of T1a stage between years



Graph 2: Change in surgical trends from open to minimal invasive (n = 588)



Graph 3: Overall survival time (months)



Graph 4: Recurrence time (months)

2007 and 2016 from 37% to around 50%).^[28] Similarly in our present study shows more patients diagnosed with early-stage and the surgical approach from open to the minimal invasive has rapidly switched and further we analyzed the subcategories of surgical techniques in; open radical nephrectomy (ORN),

OPN, LRN, LPN, robotic radical nephrectomy (RRN), and RPN (RRN). We identified that in the initial period of study 2008–2011 the maximum number of patients 89/184 (48.36%) underwent ORN. In the mid-phase 2012–2015 and last phase 2016–2019, RRN was performed significantly more 51/189 (26.98%) and 60/258 (23.25%), respectively [Table 4]. If we compare with the data from the Netherlands, 62% of cT1a underwent nephron-sparing surgery (NSS) and the age group was below 70 years, in patients with the polar location of the tumor and patients treated in high-volume hospitals. In the same study, 70% of cT1b patients underwent LRN (RN). The rate of open RN vs. laparoscopic NE has increased in patients with larger tumor sizes and tumors located in the right kidney.^[30] Advanced aged patients with T1a were treated with RN more frequently than with PN.^[31] Data from the USA support a higher rate of PN in teaching hospitals (cumulative rates of PN were 48% vs. 33% in training vs. non-training institutions respectively. In one study, the median tumor size was 3.4 (0.8–30) cm. The approaches used were minimally invasive in 42%, open in 58%, and conversions rate was 4%.^[9] In our study, the size of the tumor was significantly decreased over the period. The mean (SD) 7.32 (4), 6.44 (4.42), and 6.28 (3.63) respectively with p value 0.0452. The reduction in the size of the tumor has played a vital role in surgical procedures, so the trends increased from radical to partial nephrectomy. The Urological Society of Czech and National Health Information System, the procedures were included between 2009 and 2014. A total of 20634 (4809%–23.3% resections; 6 772%–32.8% laparoscopies) procedures were performed.^[31] Nephron sparing surgery is generally underutilized.^[10,32] Hora *et al.*^[28] reported that Nephron sparing surgery can be performed in over 85% of cT1a cases and RN is no longer an acceptable option when a PN is indicated, and might even be considered as malpractice.^[27] Laparoscopic/robotic surgery is suggested by urologists and for patients under 65 years of age.^[33] Robotic technology is associated with the increased use of PN.^[34] However, the open approach remains an important part of kidney tumor surgery. Open resections are indicated mainly in more complex tumors with higher nephrometry scores.^[35] Open nephrectomy remains the standard for treating patients with the following findings: large advanced-stage tumors and/or perinephric extension, lymphadenopathy, thrombus in the renal vein and vena cava inferior – frequently with the need of cooperation of urologist with cardiovascular surgeons.^[36,37] The highest number of cases was performed by a minimally invasive approach and nephron-sparing surgeries in the fourth quartile of the study.^[15]

Peri-operative factors

The present study evaluated that there was no significant difference between the age and the estimated blood loss for the patients between three periods of study. However, Tumor size, surgery time, and length of

hospital stay showed a significant difference between the three periods (both $P > 0.05$). There was a significant change in the age at presentation with a mean age of 57.8 years ($P = 0.031$).^[15] The mean age of the patients was mean \pm SD (54.0 ± 16.5) and mean follow up was 54.5 ± 14.2 and the mean BMI was 25.8 ± 4.3 . A study of 505 patients from Brazil reported that the average age, operative time, hospital stay, and renal tumor size were 56 years (17–84), 190.3 min (55–630), 4.7 days (1–60), and 5.9 cm (0.5–28), respectively.^[38] Their results showed there was a significant decrease in operative time, length of hospital stay, and tumor size when comparing laparoscopy to open surgeries between the periods of 2001 to 2005 and 2006 to 2010. And these three variables in our data show a similar pattern of results. Tumor size, surgery time, and length of hospital stay showed a significant difference between the three periods (both $P > 0.05$). We identified more complications in the initial time of study in open cases 6.46% Clavien-Dindo grade 1–2, those who required longer stay due to prolonged vomiting and pain, were managed conservatively and 2.38% Clavien-Dindo grade 3–4 in all period's patients underwent surgical drainage by interventional radiologist and insertion of double J stent for post-operative leakage/collection. Xia *et al.*^[39] present a review of 19 cohort studies comparing RALPN and OPN in a combined 3551 patients identified lower rates of postoperative complications, lesser transfusion rates, and less hospital stay in RALPN. Bertolo *et al.*^[40] reports results of a collaborative study of 298 patients with T2 tumors who underwent RALPN showed a 5% rate of Clavien-Dindo Grade 3 or more problems, with adequate renal functions and oncologic results; they concluded that RALPN can be applied to patients with larger size tumors in selected patients.

Oncological outcomes and survival

Recently World Health Organization (WHO) has revised the subtypes of renal cell tumors based on descriptive or characteristic features. The major subtypes are clear cell RCC (CCRCC), papillary RCC (PRCC), and chromophobe RCC (ChRCC), which comprises 56–70%, 15–20%, and 5%–7% of all RCCs, respectively. Other renal tumors based on anatomical location (collecting duct and renal medullary carcinomas), association with renal disease (acquired cystic disease-associated RCC (ACD-associated RCC), pathognomic molecular alterations (microphthalmia transcription factor [MIT] family translocation RCC and succinate dehydrogenase-deficient RCC (SDH-deficient RCC)).^[41] In our study, the type of pathology was CCRCC in 360 (61.02%), followed by PRCC in 60 (10.20%), Chromophobe in 62 (10.54%), and oncocytoma in 36 (6.12%) Mucinous tubular and spindle cell carcinoma,

multilocular clear cell carcinoma in 5 patients respectively. We also identified rare tumors like RCC associated with neuroblastoma in one patient, Xp11 translocation carcinoma in 6 patients, carcinoma of the collecting ducts of Bellini in 2 patients, we also reported tubulocystic RCC in 2 patients. Hora *et al.*^[28] reported 75.9%, 9.7%, 2.6%, and 4.2% clear RCC, PRCC, chromophobe RCC, and other benign tumors. Authors^[15] identified clear cell RCC, PRCC, Chromophobe RCC and Oncocytoma in 77.7%, 7.0%, 7.0% and 1.9% respectively. The trends of pathological stage in our study more patients were in pT1 (55.95%), followed by pT2, pT3a, pT3b-pT3c, and pT4 in 21.59%, 14.11%, 7.65%, and 0.68% respectively. Nuclear Fuhrman grade was more observed as grade 2 in 57.48% followed by grade 3 in 28.23%. Another study from other tertiary care center reported similar higher rates of grade 2 in 107/512 (49.8%) patients.^[15]

One of the studies from china of 1867 patients conducted to review the correlation between the size of RCC and its histopathological characteristics and they concluded that there was a significant correlation between tumor size and tumor grade and stage; larger tumors were more prone to have higher grade and stage, and the probability of being clear cell carcinoma grew higher as the tumor size increased.^[42] The majority of the tumor was unifocal 86%, in 70% tumor necrosis was not identified. Martinez *et al.*^[43] published the data of 354 patients and reported that patients with Sarcomatoid features, higher Fuhrman nuclear grade, larger size tumors, and the higher clinical stage had increased risk of recurrence. They identified sarcomatoid features in 7 patients, higher grade 4 in 23 patients, positive nodes in 9 patients, and positive margins in 10 patients. The sarcomatoid features in our data were present in 10.37% of the patients. The Lymph nodes were positive in 23 (3.91%) patients. The recurrence rate in our study was nearly 20% with a mean recurrence time was 41.3 months and the median time was 52.1 months and the overall survival rate was 90.13%. The mortality from RCC has continually decreased over the last decades. The study reported a decline in mortality rates (deaths from RCC per unit of the population) from 4.8 per 100,000 to 4.1 per 100,000 in men.^[44] In our study, the mortality rate was 9.86% with the meantime was 56.8 months. A similar study reported that the outcome of kidney cancer in terms of recurrence and disease-specific mortality did not change over the last 20 years. But on other hand, there was an increasing trend toward poorer recurrence-free and disease-specific survival, although it was not significant and the same pattern was identified by others.^[15,45-47] We also review and analyzed the survival time in patients from Riyadh city and outside Riyadh. There was no significant difference

in the survival time (Log-Rank $P = 0.5124$) when we compare patients by the regions. There was no significant difference in the survival time (log-rank $P = 0.4821$) when we compare patients by the primary tumors [Graph 3] Patients in the Riyadh region (median = 54.0) had a significantly higher recurrence time (Log-Rank $P < 0.0001$) than patients in other regions. Patients with the pT2 Primary Tumor (median = 70.0) had a significantly higher recurrence time (Log-Rank $P < 0.0001$) than patients with other Primary Tumors (pT) [Graph 4].

Limitations of the present study

(1) This study is subject to the limitations inherent to the retrospective design. Potential bias and reporting errors are the main risks of any retrospective study. (2) The current study was conducted at a single tertiary care center, which could be a reason for referral bias. (3) Moreover, the surgeon's experience in the robotic approach possibly played a significant role in the surgical outcomes, which was not addressed.

CONCLUSIONS

This review briefly summarizes; there was an increasing trend in the incidence of RCC, associated with a higher number of patients with comorbidities. The incidental findings of RCC on routine radiological imaging as the clinical presentation were one of the leading factors in the prevalence of RCC. The tumor size, length of hospital stays, and total operative time decreased over the period. The rapid evolution of the robotic-assisted approach becomes the most common and favorable surgical approach for the management of RCCs.

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Conflicts of interest

There are no conflicts of interest.

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