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Perioperative Care Following Open Radical Nephrectomy for Renal Cell Carcinoma

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Abstract

Background: Renal cell carcinoma (RCC) is the most common renal tumor, accounting for 85% of all renal malignancies and 2% of all cancer deaths. Occurring most commonly in the sixth to seventh decades of life.

Purpose: The study aimed to report on our experience in the management of patients with malignant renal masses regarding long-term complications and to assess the importance of long-term follow-up regarding renal function, local recurrence, and distant metastasis.

Methods: This was a hospital-based, case-retrospective, and prospective study. Total of 38 patients who had renal masses, 25 of them included in the study who had been diagnosed with RCC and underwent radical nephrectomy (RN) were investigated. Tumor-related characteristics, operative techniques, postoperative complications, full histopathological data, and follow-up results were documented.

Results: 25 patients with RCC with age distribution of 17 - 87 years median (50 y),16 male and 9 female patients with a median follow-up of 20 months (12 – 36 months), mild renal impairment in 4 patients (16%) with no need for dialysis, with proteinuria in 16% associated with history of diabetes mellitus (DM), with a mortality rate of 8%.

Conclusions: Osteoradionecrosis (ORN) is a safe procedure with low morbidity and mortality rates. Younger age at diagnosis in our study. Comorbidities and renal impairment are less than the international records, which may be attributed to the younger mean age of the patients. Subclinical metastasis remains a risk factor for death, even with strict preoperative investigations.

Keywords: Open radical nephrectomy, Renal cell carcinoma, Renal mass, Proteinuria, Dialysis

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Introduction

Renal masses may be categorized as malignant, benign, or inflammatory. Alternatively, they can be grouped based on their imaging characteristics into simple cystic lesions, complex cystic lesions, fat-containing tumors, and other solid masses [1]. RCC, historically referred to as hypernephroma due to the mistaken assumption of adrenal origin, is also known as clear cell carcinoma or Grawitz tumor [2]. RCC is a malignant epithelial neoplasm arising from the renal tubular epithelium and is the most common primary cancer of the kidneys in adults.

It is the most common renal tumor, accounting for 85% of all renal malignancies and 2% of all cancer-related deaths. RCC is considered the most lethal urological tumor, and more than 40% of RCC patients die of the disease [3, 4]. Overall, approximately 12 new cases are diagnosed per 100,000 population per year, with a male-to-female predominance of 3:2. The majority of RCC cases are believed to be sporadic, and only 2 – 3% are familial [5]. Approximately 4 – 10% of patients with RCC develop a tumor thrombus that extends into the inferior vena cava (IVC), and in some cases, the thrombus may propagate further into the right atrium [6]. There appears to be an increase in the incidence of all stages of RCC over the past few decades, when imaging, such as ultrasound and computed tomography (CT) scanning, has become more common to investigate nonspecific abdominal symptoms. In fact, RCC was historically described as the "internist's tumor" due to its tendency to present with systemic manifestations rather than localized symptoms. However, with the widespread use of modern imaging modalities and the high rate of incidental detection, it is now more appropriately considered a "radiologist's tumor." RCC most frequently occurs in individuals in their sixth to seventh decades of life [7].

Environmental studies have shown associations with the following smoking cigarettes, pipes, or cigarettes (1.4 to 2.3-fold increased risk; smoking cessation can reduce the relative risk by 20 – 50%) [8], hypertension (1.4- to 2-fold risk), obesity, renal failure and dialysis (30-fold risk), family history in a first or second-degree relative (relative risk of 2.9), analgesic phenacetin use, asbestos exposure, low socioeconomic status, and urban dwelling.

RCC histology includes conventional (70 – 80%), papillary (10 – 15%), chromophobe (5%), collecting duct (Bellini), and medullary cells [9].

RCC can spread through several pathways. Direct local extension can involve the adrenal gland, observed in approximately 7.5% of tumors larger than 5 cm, as well as invasion beyond the renal capsule into the renal vein (present in about 5% of cases at diagnosis), IVC, and occasionally the right atrium. Lymphatic dissemination typically affects the hilar and para-aortic lymph nodes (LN), whereas hematogenous metastasis most commonly involves the lungs (75%), followed by the bone (20%), liver (18%), and brain (8%) [10]. Gross invasion with penetration of the renal capsule, renal sinus, or collecting system has been reported in nearly 20% of patients. Incidental detection accounts for more than 50% of RCC cases [11]. Of the symptomatic RCCs diagnosed, 50% had hematuria, 40% had flank pain, 30% had masses, and 25% had symptoms or signs of metastatic disease [12, 13].

RCC treated by RN (laparoscopic RN or robotic-assisted RN), partial nephrectomy (PN) open PN (OPN), Localized disease—tumor ablation therapy [14] (heating (radiofrequency ablation) and cryotherapy), novel techniques (high-intensity focused ultrasound, radio-surgical ablation (cyber-knife I and others)), microwave and laser interstitial therapy remain investigational [15], and lymphadenectomy.

Randomized trials of adjuvant immunotherapy vs observation alone and the use of new tyrosine kinase inhibitors (such as sorafenib and sunitinib) are ongoing for patients with large tumors, positive nodes, surgical margins, venous invasion, and metastatic RCC. Studies have shown that therapy with sunitinib or sorafenib, either alone or in combination with surgery, can result in complete remission [16].

This study aimed to report our experience with the management of patients with malignant renal masses in Al-Imamein Al-Kadhimein Medical City.

Methods

Study design and setting

A retrospective and prospective study initially included 38 patients with renal masses who visited the urology department at Al-Imamein Al-Kadhimein Medical City between January 2023 and December 2025.

Exclusion criteria: 13 patients with renal masses excluded as the following:

- 5 patients underwent PN for small localized polar tumors.
- 5 patients found to have acute myeloid leukemia after RN.
- 3 patients with renal pelvis tumors managed with radical nephroureterectomy with bladder cuff.

The remaining 25 patients (16 men and 9 women) with RCC (based on histological diagnosis) were included in our study.

Preoperative assessment and surgical planning

For patients with renal masses diagnosed incidentally or symptomatic, a careful history with a special emphasis on medical history can affect the cardiovascular system and kidney, including smoking, hypertension, DM, and coronary artery disease.

All included patients had been preoperatively staged with CT and/or magnetic resonance imaging of the abdomen, magnetic resonance angiography (as indicated), chest X-ray, complete blood picture (CBP), liver function test, serum electrolyte, and renal function test (RFT).

During the pre-operative assessment, we classified patients as those who benefited from PN from those who preferably underwent RN according to R.E.N.A.L nephrometry scoring system (Table 1)

Intraoperative and early postoperative follow up data

Operative time, length of hospital stays, transfusion rate, and assessment of fluid input and output. RFT, CBP, electrolyte, and radiological investigations when indicated.

Perioperative prophylactic measures

- Hair clipping the day of surgery.
- Prophylactic antibiotics (3rd generation cephalosporin).
- Light bowel preparation day before surgery with n/g tube intraoperatively when indicated.
- Gum chewing.
- Pain management.
- Early ambulation.
- Chest physiotherapy.
- Early removal of foley catheter.
- Removal of the drain when no more needed.
- H_2 receptor blocker.

Patients' records

The records of the patients were reviewed, and the following data were collected: age, sex, preoperative investigations, tumor site, size, grade, type, findings during the follow-up period regarding local tumor recurrence and distant metastasis, aspects regarding operative techniques, postoperative complications, and post-operative renal function, which was assessed by measuring serum creatinine in mg/dl.

Operative procedure

When performing RN through a subcostal transperitoneal incision, a thorough exploration of the metastatic disease is performed after opening the abdominal cavity.

Table 1: R.E.N.A.L nephrometry scoring system [17].

R.E.N.A.L	1 point	2 points	3 points
(R)adius (maximal diameter)	≤ 4 cm	> 4 but >7	≥ 7 cm
(E)xophytic/endophytic	≤50%	>50%	Entirely endophytic
(N)earness of the tumor to the collecting system or sinus	≥ 7 mm	> 4 but > 7	≤ 4 mm
(A)nterior/posterior	No point given		
(L)ocation relative to the polar lines. Suffix (h) assigned if the tumor touches the main renal artery or vein	Entirely above the upper or below the lower polar lines	Lesion crossing polar lines	• <50% of mass across polar lines • or mass cross the axial renal midline • or mass entirely between the polar lines

On the left side, the colon was medially reflected to expose the great vessels. This is facilitated by the division of the splenocolic ligaments, which also helps avoid excessive traction and injury to the spleen. On the right side, the colon and duodenum were reflected medially to expose the vena cava and aorta. The operation was initiated by dissecting the renal pedicle. On the right side, the renal vein is short, and care must be taken to avoid injuring the vena cava. The right renal artery may be mobilized either laterally to the vena cava or, with a large medial tumor, between the vena cava and the aorta. On the left side, the renal vein is quite long, as it passes over the aorta. The vein is completely mobilized by ligating and dividing the gonadal, adrenal, and lumbar tributaries. The vein can then be retracted to expose the artery posteriorly, which is then mobilized toward the aorta. The renal artery was ligated with no.1 silk ligatures and divided, and the renal vein was similarly managed. The kidney was then mobilized outside Gerota's fascia with blunt and sharp dissection, as needed. The remaining vascular attachments were secured using non-absorbable sutures or metal clips. The ureter was then ligated and divided for complete removal of the kidney and adrenal glands.

The classical description of RN includes the performance of complete regional lymphadenectomy. However, the removal of LN remains controversial.

The LN can be removed either en bloc with the kidney and adrenal gland or separately after nephrectomy. Lymph node dissection begins at the crura of the diaphragm, which is the origin of the superior mesenteric artery.

There is a readily definable periadventitial plane close to the aorta that can be entered so that the dissection may be carried along the aorta and onto the origin of the major vessels to remove all peri-aortic lymphatic tissue.

Care must be taken to avoid injury to the origins of the celiac and superior mesenteric arteries as they arise from the anterior surface of the aorta.

Dissection of the peri-aortic and pericaval LN is then carried downward en bloc to the origin of the inferior mesenteric artery [18]. Currently, adrenalectomy is not performed if there is no radiological evidence of extensive renal involvement, it is locally advanced, it is located in the upper pole, or it is immediately adjacent to the adrenal gland.

Staging and grading

Staging and grading of RCC were performed based on the international tumor nodes metastasis staging system and Fuhrman's classification system for nuclear grade in RCC.

Follow up for disease progression after open RN

Based on the Novick and Campbell guidelines, a follow-up was performed, which included history, physical examination, blood tests, chest radiography, and abdominal CT. Postoperative Surveillance after RN for localized RCC [19]. Blood tests should include measurement of serum creatinine levels. In addition to the above imaging studies, ultrasound was performed for all cases at the start after 3 months, every 6 months by an experienced radiologist, 24 h urinary protein concentration 6 monthly, creatinine was performed during hospitalization, and stitches were removed after 3 months and every 6 months.

Data analysis

Microsoft Excel was used for data entry and analysis, and appropriate statistical tests for both categorical and numerical variables were used.

Results

25 patients with RCC were enrolled in this study. The mean age of the patients was 50.16 years ± 15.05, the minimum was 17 years, and the maximum was 87 years (Figure 1).

16 male patients (64%) and 9 female patients (36%) had a male:female ratio of 2:1. Right renal mass was observed in 14 (56%) patients and left mass in 11 (44%) patients (Table 2).

The operative variables demonstrated a moderate surgical duration and acceptable perioperative outcomes. The mean operative time was 3.52 ± 0.48 h, ranging from 3 to 4.5 h. The average hospital stay was 3.76 ± 1.56 days, with a range of 3 to 10 days. The mean tumor size was

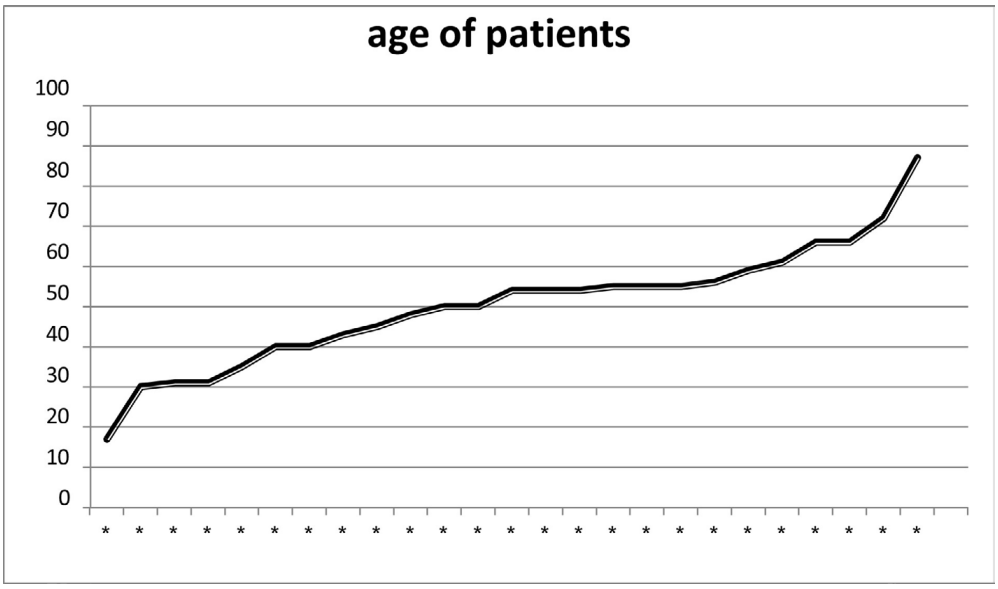

Figure 1: Chart shows age distribution.

Table 2: Baseline variables.

Variable		No.	%
Age (year)		50.16 ± 15.05	17 - 87
Sex	Male	16	64
	Female	9	36
Laterality	Right renal mass	14	56
	Left renal mass	11	44
Comorbidity	DM	4	16
	Hypertension	5	20
	Multi	2	8
Smoking	Yes	8	32
	No	17	68

8 cm, with sizes varying between 5 cm and 14 cm. IVC involvement was observed in two patients (8%), while renal vein involvement was present in one patient (4%). Positive LN were detected in 3 patients (12%). The intraoperative blood transfusion requirements ranged from 0 to 7 points, indicating variable blood loss. Overall, the findings reflect a manageable operative time, relatively short hospitalization, and limited vascular and nodal involvement in most patients (Table 3).

The frequency of RCC grade 1 was 7 (28%), grade 2 was 11 (44%), grade 3 was 5 (20%), and grade 4 was 2 (8%). The frequencies of pathological stage 1 were 13 (52%), and stage 2 was 7 (28%), stage 3 was 3 patients (12%) and stage 4 were 2 patients (8%). The frequency of the pathological subtypes of RCC was as follows: clear cell RCC, 20 (80%); papillary RCC, 3 (12%); and chromophobe RCC, 2 (8%) (Table 4).

The mean arterial pressure (MAP) showed no statistically significant changes after surgery. The preoperative MAP was 100.73 ± 11.37 mmHg, compared to a postoperative of 99.33 ± 8.96 mmHg (p = 0.299). The MAP range prior surgery was 83.33 – 123.33 mmHg, while post-surgery it ranged from 86.67 – 123.33 mmHg. Although there was a slight decrease in the mean MAP postoperatively, the difference was not statistically significant, indicating that the surgical intervention did not have a meaningful impact on the patients' MAP (Table 5).

Table 3: Operative variables.

Variables	No.	%
Operative time (h)	3.52 ± 0.48	3 - 4.5
Hospital stays (days)	3.76 ± 1.56	3 - 10
Tumor size (cm) mean/range	8	5 - 14
IVC involvement	2	8
Renal vein involvement	1	4
Positive LN	3	12
Transfusion rate (intra-op) points	-	0 - 7

Table 4: RCC variables.

Variable		No.	%
Grade	I	7	28
	II	11	44
	III	5	20
	IV	2	8
Stage	Stage 1	13	52
	Stage 2	7	28
	Stage 3	3	12
	Stage 4	2	8
Type	Clear cell	20	80
	Papillary	3	12
	Chromophobe	2	8

Table 5: Mean arterial pressure difference before and after surgery.

Parameter	Pre reduction MAP ± SD	Post reduction MAP ± SD	P value
MAP (mmHg)	100.73 ± 11.37	99.33 ± 8.96	0.299
Range	83.33 - 123.33	86.67 - 123.33	-

Note: SD is standard deviation.

Table 6: Post operative complications.

Complication	No.	%
Proteinuria	4	16
Renal impairment	4	16
Ileus	3	12
Post operative blood transfusion	2	8
Atelectasis	2	8
Metastasis	2	8
Death	2	8
Dialysis	2	8
Wound infection	1	4
Tumor recurrence at renal bed	1	4
New onset hypertension	-	-

During the follow-up period (Table 6)

One patient developed wound infection treated with daily dressing with an antibiotic cover, and the tube drain was removed before discharge on the 3rd post-operative day in most cases 2 cases remained in the hospital for 7 days because of co morbidity (ischemic heart disease, hypertension, DM). One patient remained after 10 postoperative days. Because of the intra-operative finding of local spread of the tumor with invasion to the colon, partial colectomy and colostomy were performed, and the patient died 7 months later because of metastasis. One patient had a small liver mass by imaging study proposed to be hemangioma, but later on increasing in size and number, ultrasound-guided fine needle aspiration performed for him was found to have metastasis, treated with sunitinib (tyrosine kinase inhibitor) with development of renal impairment with dialysis requirement, and the patient died 2 years later. Both cases had poor prognostic signs, including local invasion with positive LN, renal pelvic invasion, vascular invasion, histological high-grade pleomorphic malignant cells, and central necrosis. Disease-specific death during the follow-up period was observed 2 (8%). No more patients experienced disease progression (local recurrence at the surgical bed or distant metastasis).

Renal function test (creatinine) showed no significant change in creatinine, except in two patients who needed dialysis; otherwise, mild renal impairment was observed in four patients (around upper normal RFT). No deterioration in general health in most of the patients, except three patients with pre-existing co morbidities

Post-operative blood transfusion was required (1 point) in 2 patients. Atelectasis occurred in two patients. Those with well-controlled hypertension and DM still have normal general health because of a new start in their life after surgery, making them take care of themselves with a healthier lifestyle and good compliance during the follow-up period, with a mild increase in creatinine reading. Statistically significant differences were observed, but most of the readings were near the baseline readings (Table 7).

Table 7: Baseline creatinine compared with readings 6 months and 1 year later.

Base line	Mean ± SD	Range	P value
	0.93 ± 0.24	0.65 - 1.7	-
1st 6 months	1.41 ± 1.13	0.85 - 6	0.016
1st year	1.41 ± 1.2	0.92 - 7	0.023

Discussion

Recent evidence suggests that postoperative renal impairment following nephrectomy may adversely affect overall survival (OS) and increase the risk of cardiovascular events. These findings highlight the importance of considering functional outcomes alongside oncologic control when evaluating treatment strategies [20].

In our study, renal impairment with the need for dialysis occurred in two patients who had multiple co-morbidities, while those with controlled chronic medical illness showed no significant deterioration in renal function with time during the follow-up period, which may be attributed to the younger age of patients (younger patients with less co-morbidities and more compliant with treatment and follow-up), and the development of proteinuria occurred in those with DM (4 patients, 16%), which may be attributed to both risk factors for its development (DM and nephrectomy).

In addition, about 44% of the patients had hypertension, DM, or a combination of these, but with strict follow-up and compliance of the patients, about one-third of them had mild renal impairment during the follow-up period (just slight elevation above the normal range). The difference in blood pressure readings before and after RN was not statistically significant.

The mean age of patients with RCC is 65 years in Japan [21], with other studies indicating that it is primarily a disease of elderly patients, with a typical presentation in the sixth and seventh decades of life with a male to female ratio of 3:2; in our study, the male to female ratio was 2:1, with a mean age of approximately 50 years, which is lower than the international numbers.

A Japanese study assessing renal function after RN showed that younger Japanese patients with higher preoperative glomerular filtration rates (GFR) and no history of DM tended to maintain better renal function and had a lower likelihood of developing chronic kidney disease (CKD) three years after RN. However, the long-term trajectory of renal function after RN remains insufficiently defined. Consequently, the routine or excessive use of RN may not be justified in patients with a low predicted risk of postoperative CKD. Although a recent randomized trial demonstrated that RN was not associated with reduced OS [22], current meta-analytic evidence indicates that pre-existing DM is significantly correlated with poorer OS, cancer-specific survival, and recurrence-free survival among RCC patients. Therefore, individuals with RCC and concomitant DM require closer monitoring and more comprehensive management because of their less favorable prognosis [22].

For patients at an elevated risk of postoperative CKD, including those of advanced age, with pre-existing DM, or with reduced preoperative GFR, alternative management strategies such as ablative procedures or active surveillance should be considered when PN is not feasible. If RN is deemed necessary in high-risk individuals, careful postoperative monitoring is essential, including regular assessment of renal function and collaboration with nephrology specialists.

Small tumor size was associated with CKD after RN. PN should be considered in patients with a tumor size of 7 cm or less [23], which may be attributed to the removal of more normal tissue with RN.

A meta-analysis encompassing 26 studies conducted over a 37-year period demonstrated that cigarette smoking modestly but significantly increased the risk of developing RCC. While the overall association appeared stronger in men than in women, risk estimates were comparable between sexes when adjusted for the number of cigarettes smoked per day. Similarly, smoking cessation was associated with a reduced risk of RCC in both men and women [24].

However, in our study, the lack of a significant association may be attributed to the small sample size. In our study 1 patient had positive LN with disease recurrence at the renal bed was in 1 patient during the follow-up period, which may be due to the relatively short follow-up period, with subclinical metastasis occurring in 2 patients (8%) with a median time to diagnosis of 4 months with progressive deterioration and death.

Both cases had poor prognostic signs, including local invasion with positive LN, renal pelvic invasion, vascular invasion, histological high-grade pleomorphic malignant cells, and central necrosis.

In patients with RCC, tumor stage, regional LN involvement, tumor size, nuclear grade, and the presence of histological necrosis are significantly associated with progression to metastatic disease [25]. Among patients who underwent RN for clinically localized RCC, 479 (29%) developed metastases, with a median time to progression of 1.3 years during the study period (1970 – 2000). Rapid disease progression in patients who initially present without metastases may reflect aggressive tumor biology or the presence of subclinical metastases at the time of surgery.

Klatte et al. [25] reported that 5% of patients with small localized RCC experienced recurrence after RN, likely due to tumors with particularly aggressive biological characteristics [25]. In contrast, Cho et al. [26] found that patients with localized RCC without capsular invasion had a 5-year recurrence-free survival rate of 92.3% [26]. The highest risk of RCC recurrence occurs within the first 5 years after nephrectomy, with most recurrences manifesting within 3 years. However, late recurrences have been documented even up to 30 years after surgery [27].

The presence of micrometastases at the time of surgery is often associated with vascular invasion at the primary tumor site, and their comparatively lower malignant potential may contribute to late disease recurrence [28]. A distinctive feature of RCC is its propensity to involve the venous system, which occurs in approximately 10% of cases more frequently than in any other malignancy [29]. This involvement typically presents as a contiguous tumor thrombus that can extend through the IVC and, in some cases, reach the right atrium.

In our study, vascular involvement was present in three patients, two with IVC thrombus and one with tumor extension to the renal vein with a negative margin, with removal of the thrombi.

Although complications associated with open RN may be perceived as less relevant today owing to the increasing use of laparoscopic RN and PN for early stage RCC, open RN remains widely performed. Several large-scale, long-term studies have shown that both laparoscopic RN [30] and PN [31] provide oncologic outcomes comparable to those of traditional open RN in patients with localized RCC. Despite this, in the United States, fewer than half of RNs are currently performed laparoscopically [32], and only 32.2% of patients with stage I RCC undergo nephron-sparing surgery [33]. Consequently, a substantial proportion of patients continue to undergo open RN.

Localized RCC remains a primary surgical disease, and the effectiveness of tumor extirpation is paramount. Retrospective multicenter studies have demonstrated that 5-year survival following laparoscopic RN is equivalent to that after open surgery [34]. Previous

reports also highlight the feasibility of laparoscopic nephrectomy, adequacy of surgical specimens, and immediate benefits for patients, including shorter hospital stays, faster recovery, reduced postoperative pain, and improved cosmetic outcomes.

Nonetheless, concerns persist regarding whether laparoscopic RN achieves long-term oncologic outcomes comparable to those of standard open RN. Data from 5-year follow-up studies indicate that laparoscopic RN provides oncological effectiveness equivalent to that of open surgery. Similarly, retroperitoneoscopic RN using a small incision showed no significant difference in outcomes compared to the standard open approach for RCC [35]. In our institution (AL-Imamein AL-ALkadhimein Teaching Hospital), we still perform ORN or OPN, with outcomes comparable to those of international studies.

Conclusion

Open RN is a good choice procedure, with low rates of morbidity and mortality. The patients' age at diagnosis was lower in our study, which may require further study. Pre-operative morbidities may increase the risk for post-operative morbidity and complications, which in our study is less than the international records, and may be attributed to the younger mean age of the patients. Subclinical metastasis remains a risk factor for death, even with a strict preoperative investigation. With strict perioperative care and appropriate adherence to the guidelines, most of the major complications of major surgeries can be avoided.

Acknowledgements

None.

Conflicts of Interest

None.

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