Efficacy and safety of surgery in renal carcinoma patients 75 years and older: a retrospective analysis

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Abstract

Objective: To investigate the efficacy and complications of surgical treatment in patients with renal cell carcinoma aged ≥ 75 years.

Methods: From January 2009 to May 2019, we assessed 166 patients aged 75 years and older, who either had radical nephrectomy (RN) or partial nephrectomy (PN) as treatments for diagnosed renal cell carcinoma. Patients were divided into one group of patients aged 75–79 years and the second group of patients ≥ 80 years. The complications and survival were compared between the two groups.

Results: All 166 patients were successfully operated on. Differences between the two groups were statistically significant in intraoperative and postoperative complications and Clavien–Dindo score of ≥ 1 (P = 0.02, P < 0.001, P = 0.001). Univariate analysis revealed no significant correlation between a Clavien–Dindo score ≥ 1 versus gender, body mass index (BMI), lack of symptoms, KPS, baseline GFR, postoperative GFR, tumor size, tumor location, surgical method, and transfusion or no transfusion (ALL P > 0.05). Multifactor analysis showed that age ≥ 80 years, partial nephrectomy, and operation time were independent predictors of a Clavien–Dindo score ≥ 1. No significant difference was found in OS between the two groups, (P = 0.0001), and no significant difference in CSS (P = 0.056). There was no significant difference in OS and CSS between the RN and PN groups (P = 0.143, P = 0.281, respectively).

Conclusions: According to our findings, the overall safety of surgical therapy for elderly patients with renal cell carcinoma is adequate. PN should be carefully examined, especially over the age of 80. To select suitable patients based on an assessment of the tumor’s complexity and patients’ physical condition, such as age, underlying diseases and other conditions, technical feasibility, balance of benefits and a case-by-case.

Keywords: Renal cell carcinoma, Elderly, Complications, Partial nephrectomy

Introduction

Renal cell carcinoma accounts for around 4.0% of all malignant tumors in the body. In 2021, there were nearly 76,080 new cases in the United States, suggesting an increasing trend year by year [1]. Similarly, the incidence of renal cell carcinoma in China also showed a gradually increasing trend, and the incidence increased with advancing age [2]. Surgery is the primary treatment for localized renal cancer. However, for elderly patients, due to multiple underlying diseases, there is an increased
transient ischemic attacks

Brain hemorrhage, ischemic stroke, subarachnoid bleeding, but excluding ICU intensive care unit, IC intermediate care, CNS central nervous system

Table 1 Clavien–Dindo classification of surgical complications

| Grade | Definition                                                                                           |
|-------|------------------------------------------------------------------------------------------------------|
| I     | Any deviation from the normal postoperative course without the need for pharmacological treatment or surgical, endoscopic, and radiological interventions allowed therapeutic regimens: drugs as antiemetics, antipyretics, analgesics, diuretics, electrolytes, and physiotherapy. This grade also includes wound infections opened at the bedside |
| II    | Requiring pharmacological treatment with drugs other than such allowed for grade I complications Blood transfusions and total parenteral nutrition are also included |
| IIIa  | Intervention not under general anesthesia                                                          |
| IIIb  | Intervention under general anesthesia                                                              |
| IVa   | Life-threatening complication (including CNS complications)* requiring IC/ICU management            |
| IVb   | Single organ dysfunction (including dialysis)                                                        |
| V     | Death of a patient                                                                                  |

CNS central nervous system, IC intermediate care, ICU intensive care unit

*Brain hemorrhage, ischemic stroke, subarachnoid bleeding, but excluding transient ischemic attacks

Materials and methods
Patient selection and data extraction
A retrospective analysis was performed on the clinical data of 166 patients who aged ≥ 75 years at the time of surgery were consecutively enrolled with localized renal cell carcinoma, derived from the medical record system, the Department of Urology, Cancer Hospital, Chinese Academy of Medical Sciences from February 2009 to February 2019.

According to the European Association of Urology(EAU), National Comprehensive Cancer Network (NCCN), and ASCO guidelines [3, 8, 9], for patients with small renal tumors (SRM), active surveillance (AS), surgical treatment (PN or RN), thermal ablation (TA) are feasible, and recommended for elderly patients and less than 3 cm or 4 cm and the tumor growth rate is less than 0.5 cm/year, high risk and feasible active monitoring of life expectancy of less than 5 years, but the treatment methods acceptable to both doctors and patients should be established according to the characteristics of the tumor and related factors of the patients themselves, but in China there is no large sample AS and TA of research data, and also has the research shows that AS and TA compared with the surgical treatment, CSS and OS are not benefit [10], and in patients with SRM, based on the recommendations of guidelines, we will explain in detail the research data and advantages and disadvantages of AS, RN,PN and TA, and finally patients will decide the treatment method. However, due to the fear and tension after the discovery of the tumor, patients will choose more active surgical treatment.

The study cohort included 111 men and 55 women, with an age range from 75 to 89 years. The clinical data included general information such as age, gender, tumor size, surgical method, imaging, and pathology. Patients were divided into one group of patients aged 75–79 years and the second group of patients ≥ 80 years. The method of operation through a retroperitoneal approach was laparoscope or open surgery, general anesthesia, and lateral decubitus position. All the operations were completed. The patient's vital signs and drainage were closely observed after surgery, and the patients were advised to rise early in the morning and resume their diet. The intraoperative and postoperative complications were compared between the two groups, and related factors were analyzed according to the CDC.

Preoperative assessment methods
According to the Chinese Experts’ Recommendations for Preoperative Assessment of Elderly Patients (2015), physical condition assessment should be conducted first, including assessments of frailty of state, functional/
Physical state and fall risk, cognitive dysfunction, mental state, cardiac and pulmonary complication risk. Additional assessments include risk of stroke, renal function, thrombosis, bleeding risk, and nutritional status. Based on the assessment results, active medication and other treatments to control complications could be provided. Multi-Disciplinary Treatment (MDT) rounds were conducted before the operation, and the planned operation plan was formulated. The patients and their families were informed of the planned treatment plan or alternative plan, and the patients and their families were informed of the condition and signed informed consent.

Follow-up methods
All patients were reviewed regularly from 3 to 6 months, including chest X-ray, abdominal and pelvic ultrasound, blood routine examination, liver and kidney function. Abdominal and pelvic CT or abdominal MRI were reviewed every 6 months, and chest CT was reviewed after no more than one year. Regular follow-up was conducted by telephone and medical record inquiry system.

Statistical methods
IBM SPSS Statistics for Windows 20.0 was used for statistical analysis (IBM, Armonk, NY, USA). For measurement data with a normal distribution, the mean ± SD was used, and the median and range were used in a non-normal distribution. The Student’s t-test was used to examine quantitative variables. The chi-squared test, Fisher’s exact test, and Mann–Whitney U test were used to assess categorical data. Furthermore, to evaluate risk factors for the Clavien–Dindo score ≥ 1 variables were included in the univariate analysis using Fisher’s exact test. Univariate variables with a P value less than 0.10 were then included in multivariate logistic regression analysis. The OS and CSS rates were subjected to a Kaplan–Meier survival analysis. GraphPad Prism V9.0.0 was used for statistical drawing. Differences with a P value of less than 0.05 were considered statistically significant.

Results
Population characteristics
The data of patients aged 75–79 years and ≥ 80 years are summarized in Table 2. There were statistical differences in age, KPS score status, number of underlying diseases, baseline glomerular filtration rate (GFR) and postoperative GFR between the two groups (ALL P < 0.05). There were no significant differences in gender, BMI, symptoms at initial diagnosis, median tumor size and location, surgical type, surgical method, pathological type, ISUP grade, RENAL score, lymph node metastasis, and pathological stage between the two groups (P > 0.05). This suggests that the general status of the ≥ 80 years group was slightly worse than that of the aged 75–79 years group.

The method of operation through a retroperitoneal approach was laparoscope or open surgery, general anesthesia, lateral decubitus position. Among the 166 patients, 115 were treated with radical nephrectomy, 51 with partial nephrectomy, 12 with open surgery, 154 with laparoscopic surgery, three with intraoperative blood transfusion, and three with pleural injury and peripheral organ injury. The remaining patients had no obvious intraoperative complications, and all the operations were completed. The patient’s vital signs and drainage were closely observed after surgery, and the patients were advised to rise early in the morning and resume their diet.

Comparison of perioperative complications between the two groups
Comparisons of postoperative complications between aged 75–79 years and ≥ 80 years groups using the non-standardized evaluation system and CDC system are shown in Table 3. There were no significant differences in intraoperative blood loss and operation time between the two groups (P > 0.05), while there were significant differences in in-hospital stay, perioperative 90-day mortality, and Clavien–Dindo scores between the two groups (P < 0.001).

There were three intraoperative complications in the aged 75–79 years group, including two cases of blood transfusion and one case of peripheral organ injury. There were three complications in the ≥ 80 years group, including one case of blood transfusion, one case of pleural injury, and one case of peripheral organ injury. Intraoperative complications differed significantly between the two groups (P < 0.05).

There were eight cases of postoperative complications in the aged 75–79 years group, including poor wound healing in three patients, postoperative infection in one case, postoperative bleeding in one case, intestinal obstruction in one case, congestive heart failure in one case, and deep vein thrombosis in one case. In the ≥ 80 years group, there were postoperative complications in 10 cases, including poor wound healing in two cases, postoperative infection in two cases, intestinal obstruction in one case, congestive heart failure in three cases, and deep vein thrombosis in two cases. Postoperative complications differed significantly between the two groups (P < 0.05).

A total of 125 patients (75.3%) had complications Clavien–Dindo score ≥ 1. Univariate analysis revealed that the factors significantly associated with an increased
risk of complications Clavien–Dindo score ≥1 were advanced age (≥80 years), Number of underlying diseases (≥2), type of surgery (PN), and longer operative time. Multivariate logistic regression analysis of these factors showed that age (≥80 years), partial nephrectomy, and longer operation time were independent risk factors for postoperative complications Clavien–Dindo score ≥1 (Table 4).

### Table 2 Patient clinical and pathologic characteristics

| Characteristics                          | Total (n = 166) | Age 75–79 (n = 130) | Age ≥ 80 (n = 36) | P value |
|------------------------------------------|-----------------|---------------------|------------------|---------|
| Age at surgery (median)                  | 77 (75–89)      | 76 (75–79)          | 82 (80–89)       | <0.001  |
| Gender, n (%)                            |                 |                     |                  | 0.907   |
| Man                                      | 112 (67.5)      | 88 (67.7)           | 24 (66.7)        |         |
| Woman                                    | 54 (32.5)       | 42 (32.3)           | 12 (33.3)        |         |
| BMI (mean ± SD)                          | 21.5 ± 1.8      | 21.3 ± 2.5          | 21.6 ± 1.6       | 0.536   |
| KPS score < 80, n (%)                    | 23 (13.9)       | 15 (11.5)           | 8 (22.2)         | 0.016   |
| Number of underlying diseases, n (%)     |                 |                     |                  | 0.019   |
| <2                                       | 106 (63.9)      | 89 (68.5)           | 17 (47.2)        |         |
| ≥ 2                                      | 60 (36.1)       | 41 (31.5)           | 19 (52.8)        |         |
| Presenting symptom, n (%)                | 25 (15.1)       | 19 (14.6)           | 6 (16.7)         | 0.761   |
| Baseline eGFR (ml/min)                   | 70.5 ± 9.7      | 72.1 ± 5.9          | 63.1 ± 6.4       | <0.001  |
| Postoperative eGFR (ml/min)              | 61.7 ± 8.8      | 63.3 ± 5.4          | 52.1 ± 5.6       | <0.001  |
| Tumor size (median)                      | 5.1 (1.8–13)    | 5.0 (2.5–12.6)      | 5.3              | 0.314   |
| Tumor location, n (%)                    |                 |                     |                  | 0.831   |
| Left                                     | 85 (51.2)       | 66 (50.8)           | 19 (52.8)        |         |
| Right                                    | 83 (48.8)       | 64 (49.2)           | 17 (47.2)        |         |
| Surgery procedure, n (%)                 |                 |                     |                  | 0.772   |
| Open                                     | 12 (7.2)        | 9 (6.9)             | 3 (8.3)          |         |
| Laparoscopic                             | 154 (92.8)      | 121 (93.1)          | 33 (91.7)        |         |
| Surgery method                           |                 |                     |                  | 0.097   |
| Radical                                  | 115 (69.3)      | 86 (66.2)           | 29 (80.6)        |         |
| Partial                                  | 51 (30.7)       | 44 (33.8)           | 7 (19.4)         |         |
| RENAL score (partial)                    |                 |                     |                  | 0.471   |
| ≤ 9                                      | 39 (76.5)       | 33 (75.0)           | 6 (85.7)         |         |
| > 9                                      | 12 (23.5)       | 11 (25.0)           | 1 (14.3)         |         |
| Pathological type                        |                 |                     |                  | 0.960   |
| Clear cell carcinoma                     | 144 (86.7)      | 113 (86.9)          | 31 (86.1)        |         |
| Papillary                                | 11 (6.6)        | 8 (6.2)             | 3 (8.3)          |         |
| Chromophobe                              | 6 (3.6)         | 5 (3.8)             | 1 (2.8)          |         |
| Others                                   | 5 (3.0)         | 4 (3.1)             | 1 (2.8)          |         |
| ISUP grade, n (%)                        |                 |                     |                  | 0.595   |
| Low grade ≤ 2                            | 95 (57.2)       | 73 (56.2)           | 22 (61.1)        |         |
| High grade ≥ 3                           | 71 (42.8)       | 57 (43.8)           | 14 (38.9)        |         |
| Tumor necrosis, n (%)                    | 29 (17.5)       | 21 (16.2)           | 8 (22.2)         | 0.724   |
| Sarcomatoid differentiation, n (%)       | 26 (15.7)       | 19 (14.6)           | 7 (19.4)         | 0.481   |
| Lymph node metastasis, n (%)             | 8 (4.8)         | 6 (4.6)             | 2 (5.6)          | 0.816   |
| Pathological T stage, n (%)              |                 |                     |                  | 0.794   |
| T1                                       | 134 (80.7)      | 105 (80.8)          | 29 (80.6)        |         |
| T2                                       | 21 (12.7)       | 17 (13.1)           | 4 (11.1)         |         |
| T3                                       | 9 (5.4)         | 7 (5.4)             | 2 (5.6)          |         |
| T4                                       | 2 (1.2)         | 1 (0.8)             | 1 (2.8)          |         |
Table 3  Perioperative complications in elderly patients

|                          | Age 75–79 (n = 130) | Age ≥ 80 (n = 36) | P value |
|--------------------------|----------------------|-------------------|---------|
| **Intraoperative complications, n (%)** |                      |                   |         |
| Blood transfusion, n (%)  | 2 (1.5)              | 1 (2.8)           | 0.621   |
| Inferior vena cava injury, n (%) | 0 (0)                | 0 (0)             | –       |
| Pleural injury, n (%)     | 0 (0)                | 1 (2.8)           | 0.057   |
| Pulmonary embolism, n (%) | 0 (0)                | 0 (0)             | –       |
| Intraoperative death, n (%) | 0 (0)               | 0 (0)             | –       |
| Organs injury, n (%)      | 1 (0.8)              | 1 (2.8)           | 0.328   |
| Mean estimated blood loss, ml (mean ± SD) | 97.3 ± 49.5         | 94.7 ± 40.6       | 0.714   |
| Operative time, mins (mean ± SD) | 118.0 ± 45.1        | 112.1 ± 15.7      | 0.737   |
| **Postoperative complications, n (%)** | 8 (6.2)             | 10 (27.8)         | <0.001  |
| Wound healing disorder, n (%) | 3 (2.3)             | 2 (5.6)           | 0.313   |
| Infections, n (%)         | 1 (0.8)              | 2 (5.6)           | 0.056   |
| Postoperative hemorrhage, n (%) | 1 (0.8)          | 0 (0)             | 0.598   |
| Gut obstruction, n (%)    | 1 (0.8)              | 1 (2.8)           | 0.328   |
| Acute kidney injury, n (%) | 0 (0)                | 0 (0)             | –       |
| Pulmonary embolism, n (%) | 0 (0)                | 0 (0)             | –       |
| Congestive heart failure, n (%) | 1 (0.8)            | 3 (8.3)           | 0.009   |
| Deep vein thrombosis, n (%) | 1 (0.8)             | 2 (5.6)           | 0.056   |
| Median length of stay, days (mean ± SD) | 8.7 ± 2.3           | 12.0 ± 5.6        | <0.001  |
| Perioperative mortality within 90 days, n (%) | 2 (1.5)             | 3 (8.3)           | 0.035   |
| Clavien–Dindo score       |                      |                   |         |
| 0                        | 37 (28.5)            | 4 (11.1)          | 0.001   |
| 1–2                      | 91 (70.0)            | 27 (75.0)         |         |
| ≥ 3                      | 2 (1.5)              | 5 (13.9)          |         |

Table 4  Univariate and multivariate Cox analysis of risk factors associated with Clavien–Dindo score ≥ 1

|                          | Univariate | Multivariate |
|--------------------------|------------|--------------|
|                          | OR 95% CI  | P value      | OR 95% CI  | P value      |
| Age (≥ 80)               | 7.286 1.667–31.8 | 0.008 | 15.394 1.531–35.753 | 0.020 |
| Gender (male)            | 0.594 0.266–1.32 | 0.203 | – | – |
| BMI, kg/m²               | 0.914 0.745–1.12 | 0.391 | – | – |
| Presenting symptom       | 1.046 0.387–2.82 | 0.930 | – | – |
| Number of underlying diseases (≥ 2) | 2.938 1.255–6.87 | 0.013 | 1.101 0.229–5.301 | 0.905 |
| KPS (< 80)               | 1.371 0.480–3.92 | 0.556 | – | – |
| GFR, ml/min              | 0.989 0.954–1.02 | 0.572 | – | – |
| GFR, ml/min (postoperative) | 0.878 0.786–0.99 | 0.489 | – | – |
| Tumor size, cm           | 0.924 0.750–1.13 | 0.461 | – | – |
| Type of surgery (partial nephrectomy) | 5.574 1.868–16.66 | 0.002 | 3.193 1.003–10.934 | 0.046 |
| Tumor side (left)        | 1.295 0.639–2.62 | 0.473 | – | – |
| Surgery procedure (open) | 0.983 0.253–3.81 | 0.980 | – | – |
| Operative time, min      | 1.075 1.046–1.10 | <0.001 | 1.096 1.058–1.136 | <0.001 |
| Intraoperative blood transfusion (yes) | 0.650 0.057–7.36 | 0.728 | – | – |
| Intraoperative estimated blood loss, ml | 1.003 0.995–1.01 | 0.438 | – | – |

BMI body mass index, KPS Karnofsky performance status, GFR glomerular filtration rate
Comparison of survival between the two groups and RN and PN

Overall survival—After a median followup of 45.8 months (IQR: 6.4–129.9), 44 patients died (26.5%). OS at 3 and 5 years were 96.9% and 85.5% in the 75–79 years group, 79.4% and 34.4% in the ≥ 80 years group, respectively. Significant difference was found between the two groups (HR 0.20, 95% CI 0.08–0.51, P < 0.0001) (Fig. 1A).

OS at 3 and 5 years were 95.5% and 74.9% in the RN group, 87.5% and 79.1% in the PN group, respectively. No significant difference was found between the two groups (HR 1.65, 95% CI 0.84–3.21, P = 0.143) (Fig. 2A).

Cancer specific survival—There were 20 deaths (12.0%) related to cancer.

CSS at 3 and 5 years were 98.0% and 91.4% in the 75–79 years group, 90.8% and 83.1% in the ≥ 80 years group, respectively. Although there was a difference between the two groups, no significant difference was found (HR 0.26, 95% CI 0.06–1.04, P = 0.056) (Fig. 1B).

CSS at 3 and 5 years were 97.7% and 90.3% in the RN group, 93.8% and 89.1% in the PN group, respectively. No significant difference was found (HR 1.63, 95% CI 0.67–3.93, P = 0.281) (Fig. 2B).

Discussion

For localized renal cancer, major guidelines recommend surgical treatment [8, 9], including radical nephrectomy and partial nephrectomy, as well as active monitoring or radiofrequency ablation. Nephron-sparing surgery is preferred because of its advantages in protecting renal function [9]. In 2006, partial nephrectomy became the gold standard in the treatment of stage T1 tumors [11]. According to China’s seventh population census, the number of people aged 60 or over was 264.02 million, accounting for 18.7%. This was an increase of 5.44% compared with 2010, indicating that the degree of aging has further deepened. In addition,
the proportion of kidney cancer in the elderly population has further increased.

Although EORTC 30904 [12] suggested that patients undergo radical nephrectomy had improved survival, some studies supported elderly patients undergoing nephron-sparing surgery [13]. Thus, the advantages of the two surgical methods remain controversial. For elderly patients, it is not clear how to choose between the two surgical methods and whether partial nephrectomy is beneficial [14–16]. Therefore, the choice of surgical method depends on patient characteristics and the functions of various organs [17], especially for patients over 75 years old. Additionally, the expected survival of patients and the possible complications caused by surgery that may affect the quality of life of patients should also be assessed.

Previous studies suggest that there are more complications associated with basic diseases, such as hypertension and heart disease, in elderly patients over the age of 70. However, there were no significant differences in operative time, blood loss and perioperative complications between patients under the age of 70 and patients undergoing laparoscopic radical nephrectomy. The incidence of intraoperative complications was 2.9% and 5.3%, respectively, and the incidence of postoperative complications was 8.8% and 4.2%, respectively. In comparison, the incidence of postoperative complications was higher in patients over 70 years old of age [18].

Berdjis et al. [19] conducted a study on 115 renal cancer patients over 75 years old and 908 patients under 75 years old who received surgical treatment. The finding was that age is not a contraindication for surgery. Overall complications and mortality of patients over 75 years old showed no significant difference compared with those under 75 years old, but most of them were radical nephrectomy, and partial nephrectomy accounted for only 13.4%. Staehler et al. [20] analyzed 117 patients with renal cancer who underwent surgical treatment and found that the incidence of perioperative complications of partial nephrectomy and radical nephrectomy was 12% and 15%, respectively, and the incidence of complications within 30 days was 4% and 7%, with no significant difference. However, Sun et al. [21] found that there were more complications in elderly patients over 75, and death was mostly due to cardiovascular and cerebrovascular diseases and non-tumor causes. Many studies support nephron-sparing surgery for elderly patients [13].

It should be noted that most of the previous studies were analyzed by age grouping at the age of 75 or by surgical grouping. In particular, there are few stratified studies on elderly patients aged over 75. The current study collected the data of 166 patients over 75 years old in our hospital and analyzed the general information, complications, and survival.

There was a substantial statistical difference in preoperative baseline eGFR between the two groups, which was thought to be due to age. There was also a significant difference in postoperative GFR (reexamination within 1 week following surgery) between the two groups. All patients’ postoperative eGFR decreased, and as compared to the 75–79 years group, the ≥80 years group experienced a higher percentage drop in eGFR from baseline. Phillip et al. [22] and Rivero et al. [23] discovered that RN is related to worse renal outcomes than PN. Another study [24] confirmed that eGFR loss related to renal cancer surgery, whether due to PN or RN, increases the risk of chronic kidney disease but has a lesser influence on survival. In our study, there were no cases of chronic renal disease or fatalities from it in either group, which may be connected to the larger number of patients undergoing RN in this group. We believe that baseline renal function and age, which reflect general health conditions, can predict long-term renal functional results independent of surgery type. Therefore, a patient with a large tumor and chronic kidney disease may benefit from PN.

Our study found that the 75–79 years group had superior survival to the ≥80 years group (P < 0.0001). The results were similar to the previous studies [13, 25, 26]. This is mainly associated with older age, poor basic conditions, lower overall life expectancy, and a higher proportion of deaths from non-tumor mortality. In the ≥80 years group, a total of 17 patients died, 12 (70.6%) died of non-tumor causes, in the 75–79 years group, a total of 27 patients died, 12 (44.4%) died of non-tumor causes. And there was no significant difference was found in CSS between the two groups, although it was greater in the 75–79 years group, which may be related to the cause of death (P = 0.056).

Although most results suggest that OS is better with PN than with RN [27–30], similarly, most studies have shown that PN and RN have similar OS in patients, PN was not beneficial in terms of OS in elderly patients (≥65 years old), the 5-year OS rates after surgery were 94.7% for PN versus 91.9% for RN (P = 0.698) [13, 31]. And no significant difference was found (P = 0.281) in CSS in our study. Several previous studies have also found similar or opposite results. The Meta-Analysis (a total of 60 studies) showed that CSS estimates among all management strategies were 95 to 100% and did not differ significantly among treatments. Comparative analyses of RN and PN indicated that increasing age, larger tumor size, and higher tumor grade were the most common predictors of worse CSS [32]. However, some studies showed...
no difference in CSS between RN and PN when stratified by age, tumor size or grade [33–35]. Further confirmation is needed from larger samples and prospective controlled studies.

Using the Clavien–Dindo classification method, postoperative complications were defined as complications occurring within 30 days after surgery [5]. In our study, the overall complication rate was 14.45%, it was higher than that in previous studies, which may be related to the age composition of patients and the choice of surgical methods. In our study, patients aged ≥ 80 years accounted for 21.7%, and partial nephrectomy accounted for 30.7%. However, most of the previous studies focused on radical nephrectomy. The results of our study suggest that partial nephrectomy should be fully evaluated for patients ≥ 80 years of age. Although studies have shown a gradual increase in the use of partial nephrectomy in patients ≥ 65 years of age (41% in patients over 75 and 14.9% in patients over 80), the increased application rate was not significantly correlated with the presence of concomitant diseases such as heart disease ($P = 0.256$), kidney disease ($P = 0.419$), diabetes ($P = 0.808$), and hypertension ($P = 0.931$); thus patients could benefit from nephron-sparing surgery [36]. However, that study only analyzed the application of partial nephrectomy in elderly patients in recent years and its impact on survival without summarizing the perioperative complications. Our study suggests partial nephrectomy application showed more complications in elderly patients, especially in patients aged ≥ 80 years with a lengthy hospital stay, with higher mortality. In addition, the findings of Chung et al. suggested that partial nephrectomy did not significantly prolong the survival of elderly patients [13].

Therefore, for patients over the age of 75, and especially for those aged ≥ 80, partial nephrectomy should be carefully selected. Further data collection is needed to verify whether partial nephrectomy is beneficial to prolong survival. However, the purpose of our study was not to reduce the use of partial nephrectomy in elderly patients but to select suitable patients based on clinical characteristics. The surgical risk prediction model can be used for preoperative risk prediction just like the Model of the American College of Surgeons to carry out precision surgical treatment [37]. Due to the retrospective study being conducted after a considerable length of time, differences in the proficiency of surgeons and the selection of surgical methods may have resulted in biased results. The benefit of surgery in elderly patients with renal cancer remains controversial. This retrospective study aimed to explain the perioperative complications and survival of these patients, to further understand if the surgery benefits. Different from previous studies, the enrolled patients in this study were all elderly patients aged ≥ 75 years, and the conclusions were drawn after grouping analysis to further clarify the advantages and disadvantages of surgery, especially complications using the CDC system.

In conclusion, our study suggests that the overall safety of surgical treatment for elderly patients with renal cell carcinoma is satisfactory. PN should be carefully considered for patients aged ≥ 80 years, as the incidence of intraoperative and postoperative complications is relatively high. It was not to reduce the use of partial nephrectomy in elderly patients, it could be helpful in evidence-based clinical decision-making but should be critically interpreted based on an assessment of the complexity of the tumor and patient’s physical condition such as age, underlying diseases and other conditions, technical feasibility, and balance between benefits and risks. Nevertheless, further research and data are needed to strengthen many aspects of the evidence base.

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Author contributions
All authors participated in designing various parts of the study and in discussion and interpreting the results. HSB and WXJ collected the samples and clinical information. WXJ performed the data analysis. HSB and DW accessed the raw data. HSB wrote the manuscript with input from all authors. JZS, CLL, and NZX review the article and direct the writing. All authors read and approved the final manuscript.

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Availability of data and materials
All of the data are from the National Cancer Center/National Clinical Research Center for Cancer/Cancer Hospital, Chinese Academy of Medical Sciences and Peking Union Medical College. The datasets generated and analysed during the current study are not publicly available due to patient privacy issues (The raw data includes the patient’s name and phone number) but are available from the corresponding author on reasonable request (Dong Wang mobile phone: + 86 1301017215, E-mail: wangdong1199@126.com).

Declarations
Ethics approval and consent to participate
Approval for this study was granted by the Ethics Committee of National Cancer Center/National Clinical Research Center for Cancer/Cancer Hospital, Chinese Academy of Medical Sciences and Peking Union Medical College, Beijing, China. Written informed consent was obtained from all patients before administering treatment. All methods were performed following the relevant guidelines and regulations.

Consent for publication
Not applicable.

Competing interests
The authors declare that they have no competing interests.
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