

## Research Article

# A Retrospective Analysis of Renal Function in Patients after Radical or Partial Nephrectomy

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**Abstract**

**Objective:** To examine the change in renal function and relationship between preoperative renal function and chronic kidney disease (CKD) progression after radical nephrectomy (RN) or partial nephrectomy (PN).

**Patients and Methods:** We studied 268 patients who underwent RN or PN between January 2002 and December 2009. The estimated glomerular filtration rate (eGFR) was determined using serum creatinine levels. Patients were divided into three groups according to the preoperative eGFR.

**Results:** Group 1 (eGFR > 90 mL/min/1.73 m<sup>2</sup>) patients who underwent PN retained a significantly higher eGFR at 3 months to 1 year than those who underwent RN. New-onset CKD was found in 28% and 0% of Group 1 patients who underwent RN and PN, respectively. Group 2 (eGFR = 60-90 mL/min/1.73 m<sup>2</sup>) patients who underwent PN retained a significantly higher eGFR at 2 months to 6 years than those who underwent RN. New-onset CKD was found in 78.8% and 18.5% of Group 2 patients who underwent RN and PN, respectively. Group 3 (eGFR < 60 mL/min/1.73 m<sup>2</sup>) patients who underwent PN retained a higher eGFR than those who underwent RN.

**Conclusions:** Patients undergoing RN have a high rate of new-onset CKD. Our findings suggest that PN is better for retaining long-term renal function.

**Keywords**

- Renal tumor
- Renal function
- Radical nephrectomy
- Partial nephrectomy
- Chronic kidney disease

**ABBREVIATIONS**

CKD: Chronic Kidney Disease; RN: Radical Nephrectomy; PN: Partial Nephrectomy; eGFR: estimated Glomerular Filtration Rate; RCC: Renal Cell Carcinoma; S-Cr: Serum Creatinine; CRI: Chronic Renal Insufficiency

**INTRODUCTION**

Radical nephrectomy (RN) has been the standard treatment for renal cell carcinomas (RCC) for nearly 50 years. However, the use of advanced abdominal imaging techniques has increased the diagnosis of small incidental renal lesions. Partial nephrectomy (PN) is currently an established, effective treatment for patients with renal insufficiency and those with small early-stage tumors.

Chronic kidney disease (CKD) is defined as an estimated glomerular filtration rate (eGFR) of < 60 mL/min/1.73 m<sup>2</sup> or by the presence of proteinuria or abnormal imaging studies for 3 months or more. CKD is associated with increased risks of cardiovascular morbidity, hospitalization, and death [1,2]. Patients with RCC often have impaired renal function and are at risk of rapid CKD progression.

In general, PN provides similar oncological control to RN but is superior to RN at preserving renal function and preventing CKD [3]. However, patients undergoing PN may be at risk of local recurrence due to either inadequate tumor excision or multifocal renal tumors. A recent article showed that PN reduced the incidence of moderate renal dysfunction compared with RN [4]. Another study reported that both operative procedures provided good oncological outcomes, although PN was considered to be significantly less effective than RN regarding overall survival in the intention-to-treat population [5]. Therefore, it is necessary to assess renal function carefully and systematically in patients when deciding between RN and PN.

As to ethnic differences of renal function, decline of eGFR was reported to be slower in Japanese population in comparison with those in the United States and Norway in general population [6]. Most of reports on post-operative renal functions in patients with renal cell cancer were from the Western countries, and Japanese studied were limited [7,8]. Furthermore, renal functions were not stratified by preoperative eGFR in these Japanese studies. Therefore, we aimed to examine the incidence of preoperative renal function for CKD progression in Japanese patients

undergoing RN or PN in the current study. This was achieved by conducting retrospective analysis of patients after RN or PN to determine changes in renal function and degree of functional reduction after nephrectomy. Preoperative CKD and non-CKD groups were analyzed separately.

## MATERIALS AND METHODS

We identified 268 patients (188 men, 80 women) with RCC and other cancers who underwent open or laparoscopic RN (n = 228) or open PN (n = 40) between January 2002 and December 2009. Pre- and postoperative serum creatinine (S-Cr) levels were used to determine eGFR. Demographics were recorded, including age, sex, disease characteristics, outcome measured as postoperative eGFR, and time to development. The long-term effects of nephrectomy on renal function were assessed by comparing the pre- and postoperative eGFR.

The patients were divided into three groups according to their preoperative eGFR: Group 1, eGFR > 90 mL/min/1.73 m<sup>2</sup>; Group 2, eGFR = 60–89 mL/min/1.73 m<sup>2</sup>; and Group 3 eGFR < 60 mL/min/1.73 m<sup>2</sup>. Each group was analyzed individually. RN and PN were performed in 50 and 7 patients, respectively, in Group 1; in 104 and 27 in Group 2; and in 74 and 6 in Group 3.

The eGFR of each patient was calculated with the modification of diet in renal equation recently modified for Japanese patients, as regulated by The Japanese Society of Nephrology as follows [9].

$$\text{eGFR} = 194 \times \text{S-Cr mg/dL}^{1.094} \times \text{Age}^{0.287} (\text{if female} \times 0.839)$$

Differences in the means of eGFR each time points between the RN and PN groups were compared using Student's t-test for continuous variables and the chi-square test for categorical variables. All *P* values were based on two-sided tests of significance, with *P* < 0.05 considered statistically significance. The analyses were performed using the Statistical Package for Social Sciences software, version 21.0 (SPSS, Chicago, Illinois, USA). This study was approved by Institutional Review Board of Gunma University Hospital.

## RESULTS AND DISCUSSION

### Results

Table (1) summarizes the patient characteristics. In total, 228 patients underwent RN and 40 underwent PN. There were no significant differences in preoperative eGFR between the RN and PN groups, while age and mean follow-up differed. RCC was found in 61.0% of the patients who underwent RN and in 92.5% of those who underwent PN. The median (range) follow-up period was 2.6 (0.25–8) years in the RN group and 3.5 (0.5–8) years in the PN group.

Figure (1) shows the time-related changes in eGFR after PN or RN in Group 1. In this group, patients who underwent PN retained a significantly higher eGFR for 3 months to 1 year than those who underwent RN. However, the differences between the PN and RN groups were not significant 2 to 6 years after surgery.

In Group 2, patients who underwent PN retained a significantly higher eGFR for 3 months to 6 years postoperatively compared with those who underwent RN (Figure 2).

As shown in Figure (3), the Group 3 patients who underwent PN retained a higher eGFR than those who underwent RN at the last group follow-up. However, the differences between the PN and RN groups were significant only at 2, 3, and 5 years after surgery.

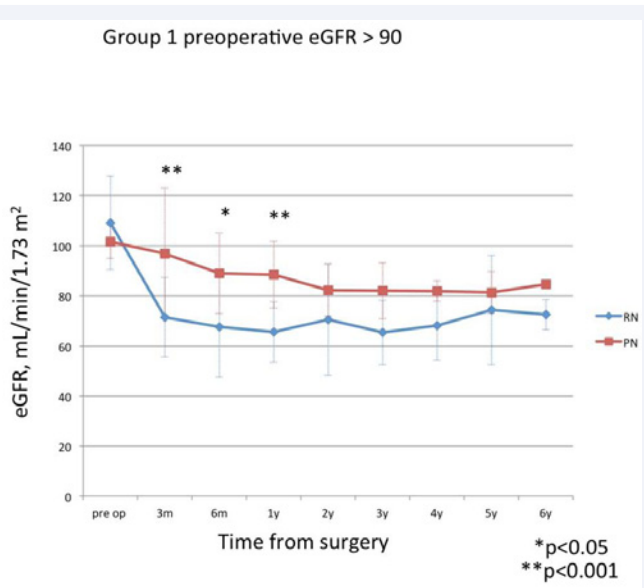
Table (2) compares the pre- and postoperative distribution and changes in eGFR according to type of surgery and group. In Group 1, eGFR decreased in 96.0% of the patients who underwent RN and 42.9% of those who underwent PN. New-onset CKD was found in 28% and 0% of the Group 1 patients who underwent RN and PN, respectively.

In Group 2, eGFR decreased in 78.8% and 18.5% of the patients who underwent RN and PN, respectively. New-onset CKD was found in 78.8% and 18.5% of the Group 2 patients who underwent RN and PN, respectively.

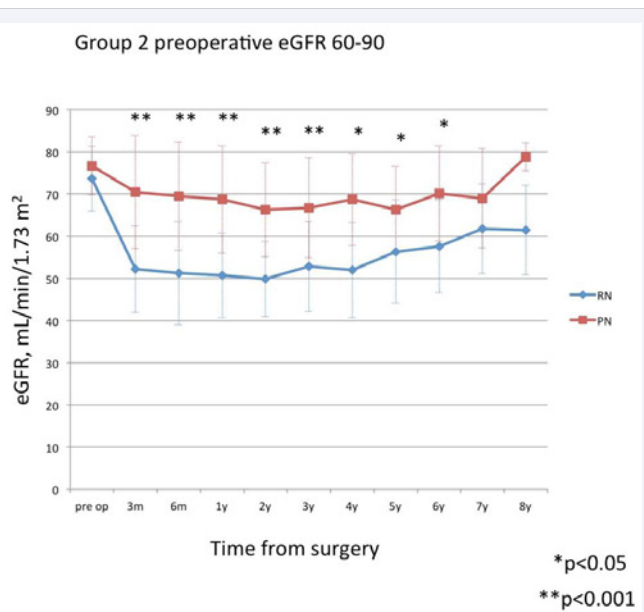
### Discussion

CKD is associated with an increased risk of cardiovascular

Table 1: Patient characteristics.			
	RN (n = 228)	PN (n = 40)	P
Age at surgery, median yr (range)	63.8 (21–88)	57.5 (25–77)	0.005
Sex			
Male, n (%)	162 (71.1)	26 (65)	
Female, n (%)	66 (28.9)	14 (35)	
Follow-up, median (range)	2.6 (0.25–8)	3.5 (0.5–8)	0.005
Preoperative eGFR, median	76.3	72.7	0.388
Tumor characteristics			
RCC, n (%)	139 (61.0)	37 (92.5)	
Others, n (%)	89 (39.0)	3 (7.5)	
Malignancy	79	0	
Infection	5	0	
Renal cystic disease	5	3	
<b>Abbreviations:</b> RN: Radical Nephrectomy; PN: Partial Nephrectomy; EGFR: Estimated Glomerular Filtration Rate; RCC: Renal Cell Carcinoma			



**Figure 1** Time-related changes in estimated glomerular filtration rate (eGFR) after surgery in patients with a preoperative eGFR of > 90 mL/min/1.73 m<sup>2</sup> (Group 1) who underwent radical nephrectomy (RN) or partial nephrectomy (PN). Measurements were made preoperatively (pre op) and 3 and 6 months and 1 and 6 years postoperatively (post op).

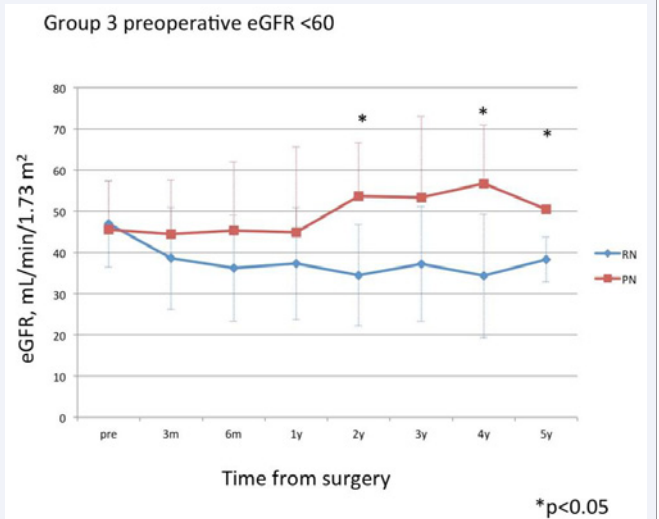


**Figure 2** Time-related changes in eGFR after surgery in patients with a preoperative eGFR of 60–90 mL/min/1.73 m<sup>2</sup> (Group 2) who underwent RN or PN. Measurements were made preoperatively (pre op) and 3 and 6 months and 1 and 8 years postoperatively (post op).

morbidity, hospitalization, and death [1,2]. This study examined the effects of preoperative renal function on CKD progression in patients after RN or PN.

Several reports have shown that PN is superior to RN in preserving renal function and preventing CKD [3,4,10-13]. Recently, Malcolm et al., investigated the incidence of chronic

renal insufficiency (CRI) that developed in 749 patients who underwent RN or PN, and showed that the patients who underwent RN had a significantly greater prevalence of CRI [3]. Huang et al., showed that the risk of new-onset CKD was significantly greater in patients with small renal cortical tumors undergoing RN than those undergoing PN [17]. Roos et al., compared perioperative morbidity and overall survival in patients younger than 55 years, and older than 65 years, who underwent RN or PN for renal tumors more than 4 cm in diameter and reported that regardless of age, patients who underwent RN had a higher incidence of new-onset CKD than patients who underwent PN [11]. Pettus et al., investigated the associations of preoperative renal function and comorbidity index on survival in patients with renal tumors, and showed that a preoperative eGFR of < 60 mL/min/1.73 m<sup>2</sup> was significantly associated with overall survival [12]. More recently, results of randomized study on the impact of RN and PN for postoperative renal functions were reported [4]. The incidence of moderate impairment of renal function, i.e., eGFR < 60 was reduced by PN, however, no significant differences were observed in overall survival in both groups [4].



**Figure 3** Time-related changes in eGFR after surgery in patients with a preoperative eGFR of < 60 mL/min/1.73 m<sup>2</sup> (Group 3) who underwent RN or PN. Measurements were made preoperatively (pre op) and 3 and 6 months and 1 and 5 years postoperatively (post op).

**Table 2:** Comparison of the pre- and postoperative distribution and changes of eGFR according to type of surgery and group.

Group 1, preoperative Egfr > 90	RN (n = 50)	PN (n = 7)
eGFR > 90 last available follow-up, n (%)	2 (4%)	4 (57%)
eGFR 60–90 last available follow-up, n (%)	34 (68%)	3 (42.9%)
eGFR < 60 last available follow-up, n (%)	14 (28%)	0 (0%)
Group 2 preoperative eGFR 60–90	RN (n = 104)	PN (n = 27)
eGFR > 90 last available follow-up, n (%)	0 (0%)	2 (7.4%)
eGFR 60–90 last available follow-up, n (%)	22 (22.2%)	20 (74%)
eGFR < 60 last available follow-up, n (%)	82 (78.8%)	5 (18.5%)

**Abbreviations:** EGFR: Estimated Glomerular Filtration Rate; RN: Radical Nephrectomy; PN: Partial Nephrectomy

In our study, we confirmed that RN was a significant risk factor for CKD with a more frequent onset of CKD in Group 1 patients who underwent RN compared with those who underwent PN. New-onset CKD was also higher in Group 2 patients who underwent RN. These findings suggest that PN is more beneficial for retaining long-term renal function. Although Group 1 patients who underwent PN retained significantly higher eGFR for 3 months to 1 year than those who underwent RN, there were no significant differences in the long-term outcomes (2–6 years) between RN and PN groups. These data suggest that the contralateral kidney can compensate for impaired renal function for several years in patients with a preoperative eGFR of > 90 mL/min/1.73 m<sup>2</sup> who underwent RN.

Similar results have been reported by Shirasaki et al., who showed that 155 of 172 patients (90.1%) who underwent RN for renal cancer had postoperative S-Cr levels of < 1.6 mg/dL. They suggested that aging, high proteinuria, hypertension, and diabetes mellitus were major risk factors for deterioration in renal function after RN [14]. Takeshita et al., reported that for overall and cancer-specific survivals, postoperative renal dysfunction after RN did not represent an independent risk factor [15].

Recently, the indications for PN have broadened. According to the 2014 RCC guidelines of the European Association of Urology, PN is the standard treatment for patients with a clinically localized RCC < 4 cm [16-18]. Several studies have suggested that PN can be used for RCCs sized 4-7 cm [10,11,18,19].

Patients undergoing PN are at risk of local recurrence due to inadequate tumor excision or multifocal renal tumors. Therefore, it is necessary to assess renal function in patients carefully and systematically when deciding between RN and PN. Chapman et al., [20] also emphasized this issue and RN has remained the treatment of choice for managing RCC in patients with a preoperative eGFR of > 90 mL/min/1.73 m<sup>2</sup>.

Our study had several limitations, including significant differences in age, mean follow-up periods, the number of patients between RN and PN groups. The PN group was significantly younger ( $P < 0.005$ ), and as previously mentioned, it is well known that an age of more than 60 years is associated with CKD progression after surgery. Second, this study included a small number of patients and the comparisons were not randomized. Third, we did not consider some well-known risk factors, such as the existence of hypertension, diabetes mellitus, and hyperlipidemia, because of insufficient records. However, the current study showed the associations of preoperative CKD stages and changes of postoperative renal functions in both surgical methods in the Japanese population. In spite of the limitations, it strengthened this study.

## CONCLUSION

our findings suggest that PN is more beneficial for retaining long-term renal function. Although RN is a significant risk factor for CKD, we have shown that in patients with a preoperative eGFR of > 90 mL/min/1.73 m<sup>2</sup> undergoing RN, the contralateral kidney may compensate for impaired renal function for several years.

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TS were responsible for acquisition of data, drafting of

manuscript and preparation of the figures and table. KI and MN operated the patient and revised manuscript. YS, YM and KS were responsible for critical revision of the manuscript. All authors read and approved the final manuscript.

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