



## Original article

# The natural history of renal function after surgical management of renal cell carcinoma: Results from the Canadian Kidney Cancer Information System

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Received 1 December 2015; received in revised form 2 May 2016; accepted 23 May 2016

## Abstract

**Introduction and objective:** Patients who undergo surgical management of renal cell carcinoma (RCC) are at risk for chronic kidney disease and its sequelae. This study describes the natural history of renal function after radical and partial nephrectomy and explores factors associated with postoperative decline in renal function.

**Methods:** This is a multi-institutional cohort study of patients in the Canadian Kidney Cancer Information System who underwent partial or radical nephrectomy for RCC. Estimated glomerular filtration rate (eGFR) and stage of chronic kidney disease were determined preoperatively and at 3, 12, and 24 months postoperatively. Linear regression was used to determine the association between postoperative eGFR and type of surgery (radical vs. partial), duration of ischemia, ischemia type (warm vs. cold), and tumor size.

**Results and limitations:** With a median follow-up of 26 months, 1,379 patients were identified from the Canadian Kidney Cancer Information System database including 665 and 714 who underwent partial and radical nephrectomy, respectively. Patients undergoing radical nephrectomy had a lower eGFR (mean = 19 ml/min/1.73 m<sup>2</sup> lower) at 3, 12, and 24 months postoperatively ( $P < 0.001$ ). Decline in renal function occurred early and remained stable throughout follow-up. A lower preoperative eGFR and increasing age were also associated with a lower postoperative eGFR ( $P < 0.01$ ). Ischemia type and duration were not predictive of postoperative decline in eGFR ( $P > 0.05$ ). Severe renal failure (eGFR < 30 ml/min/1.73 m<sup>2</sup>) developed postoperatively in 12.5% and 4.1% of radical and partial nephrectomy patients, respectively ( $P < 0.001$ ).

**Conclusions:** After the initial postoperative decline, renal function remains stable in patients undergoing surgery for RCC. Patients undergoing radical nephrectomy have a greater long-term reduction in renal function compared with those undergoing partial nephrectomy.

Funding for this study was provided by Pfizer Canada and Novartis Canada who provided an unrestricted grant to help with data collection for the Canadian Kidney Cancer Information System (CKCis).

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<http://dx.doi.org/10.1016/j.urolonc.2016.05.025>

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Ischemia duration and type are not predictive of postoperative renal function when adhering to generally short ischemia durations. © 2016 Elsevier Inc. All rights reserved.

**Keywords:** Renal function; Partial nephrectomy; Radical nephrectomy; Renal failure; Renal cell carcinoma

## 1. Introduction

The standard of care for localized renal cell carcinoma (RCC) remains surgery with either partial or radical nephrectomy. Excellent cancer control is achievable, but the loss of nephrons can predispose patients to chronic renal failure and its sequelae.

Multiple small studies have addressed the association between type of surgery and renal functional outcomes. Partial nephrectomy results in a significantly lower risk of renal dysfunction than radical nephrectomy [1–4]. The role of ischemia duration and ischemia type (warm vs. cold) in the preservation of renal function in patients undergoing partial nephrectomy is not clear as available studies provide conflicting results [5–9]. Whether these surgical factors affect renal function in a modern cohort of patients with short ischemia durations remains understudied and unknown.

We have studied and report on the natural history of renal function after radical and partial nephrectomy in a Canadian multi-institutional cohort as well as the association between surgical factors and renal functional outcomes in patients undergoing partial nephrectomy.

## 2. Materials and methods

Patients were identified from the Canadian Kidney Cancer Information System (CKCis). CKCis is a multi-institutional database of patients with RCC and includes patients from 15 Canadian academic institutions. All patients who underwent either partial or radical nephrectomy were identified for potential study inclusion. Patients were included if they had both a preoperative measurement of serum creatinine within 6 months of surgery and at least 1 postoperative measurement >30 days postoperatively. Patients were excluded only if either of these estimated glomerular filtration rate (eGFR) measurements were unavailable. Data recorded included baseline demographics, presence of diabetes preoperatively, presence of hypertension preoperatively, type of surgery, tumor characteristics, and serum creatinine measurements both preoperatively and postoperatively. For patients undergoing partial nephrectomy, the ischemia type (cold vs. warm) and the ischemia duration were also collected when available.

eGFR was calculated at baseline (preoperatively) and at 1 to 5 months, 9 to 15 months, and 21 to 27 months postoperatively using the Chronic Kidney Disease Epidemiology Collaboration equation [10]. When multiple values were available for a patient, the values measured closest to surgery and to 3, 12, and 24 months postoperatively were

chosen and are labeled as such in this study. The stage of chronic kidney disease (CKD) was determined both preoperatively and postoperatively according to the National Kidney Foundation staging system (Table 1) using the eGFR calculation closest to surgery and the lowest value postoperatively, excluding the first month [11]. Univariable and multivariable linear regression were used to compare the change in eGFR in patients undergoing partial or radical nephrectomy. The covariables in this multivariable model included age, sex, preoperative hypertension, preoperative diabetes mellitus, and baseline eGFR. Similarly, univariable and multivariable linear regression were used to determine the association between operative factors (ischemia type and duration) and postoperative eGFR in patients undergoing partial nephrectomy. The covariables in this model included age, sex, baseline eGFR, and tumor size.

## 3. Results

In total, 2,798 patients were identified in the CKCis database who underwent either partial or radical nephrectomy. Of these, 1,419 were excluded because of a lack of either preoperative or postoperative eGFR data, leaving 1,379 patients for inclusion who met the study criteria. The median follow-up was 26 months, and all included patients underwent surgery since 2008. Patients undergoing partial nephrectomy had significantly smaller tumors than those undergoing radical nephrectomy (median maximum diameter = 3.0 vs. 7.5 cm, respectively) and slightly higher baseline eGFR (83.7 vs. 76.8 ml/min/1.73 m<sup>2</sup>). There were no differences in the proportion of patients with diabetes or hypertension in the partial or radical nephrectomy groups ( $P = 0.384$  and  $0.063$ , respectively). Table 2 shows baseline characteristics for all patients.

Patients undergoing radical nephrectomy had a significantly lower postoperative eGFR compared with those undergoing partial nephrectomy with an eGFR of 19.6, 19.9, and 19.6 ml/min/1.73 m<sup>2</sup> lower at 3, 12, and 24 months

Table 1  
Stages of chronic kidney disease and corresponding GFR according to the National Kidney Foundation Staging System [11]

Stage	GFR
1	≥ 90
2	60–89
3	30–59
4	15–29
5	< 15 Or dialysis

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