

Risk factors for acute renal failure in nephrectomized patients treated in a university hospital

João Paulo Pretti Fantin¹, Ronaldo de Carvalho Neiva¹, Marcio Gatti², Pedro Ferraz de Arruda², José Germano Ferraz de Arruda², Thiago Antoniassi², Luís Cesar Fava Spessoto², José Carlos Mesquita², Lilian Castiglioni³, Fernando Nestor Fácio Júnior²

¹Resident in Urology, ²Department of Urology, ³Department of Biostatistics, Hospital de Base of the Medicine School in Sao Jose do Rio Preto (FAMERP), São Paulo, Brazil

Contributions: (I) Conception and design: FN Fácio Júnior, JP Fantin, LC Spessoto; (II) Administrative support: FN Fácio Júnior, JP Fantin, LC Spessoto, L Castiglioni; (III) Provision of study materials or patients: FN Fácio Júnior, JP Fantin, R de Carvalho Neiva, M Gatti, PF de Arruda, T Antoniassi, LC Spessoto; (IV) Collection and assembly of data: FN Fácio Júnior, JP Fantin, R de Carvalho Neiva, M Gatti, PF de Arruda, T Antoniassi, LC Spessoto, JC Mesquita; (V) Data analysis and interpretation: FN Fácio Júnior, JP Fantin, R de Carvalho Neiva, L Castiglioni; (VI) Manuscript writing: All authors; (VII) Final approval of manuscript: All authors.

Correspondence to: Fernando Nestor Fácio Júnior, MD, PhD. Department of Urology, Medical School of São José do Rio Preto, Ave. Fernando C. Pires 3600, CEP 15015-040, São Paulo, Brazil. Email: fnfacio@yahoo.com.br.

Background: New surgical techniques for nephrectomy mainly related to early diagnosis made possible by advances in imaging studies have been developed in recent decades. However, postoperative renal dysfunction is a constant concern because of the major problems faced by healthcare services and by the patients themselves. To assess risk factors for developing acute renal failure (ARF) in patients submitted to nephrectomy in a university hospital.

Methods: Seventy-seven patients submitted to nephrectomy for benign and malignant diseases in a university hospital were evaluated in respect to preoperative and postoperative creatinine clearance. Demographic (gender, age), clinical (cancer, diabetes, high blood pressure, chronic kidney disease) and surgical (anesthesia time, open or laparoscopic surgery) variables were also analyzed.

Results: Of the 77 patients, 72 met the inclusion criteria. Of these, ten (13.8%) had a diagnosis of chronic renal failure (CRF), 30 (48%) had stage I ARF and one (16.1%) had stage II ARF. The anesthesia time, type of surgery (open or laparoscopy), total or partial nephrectomy, the side of the procedure, hypertension, diabetes, CRF, renal cancer, preoperative and postoperative creatinine concentrations were analyzed. Only the difference between preoperative and postoperative creatinine clearance was clinically significant ($P < 0.001$).

Conclusions: An altered preoperative renal function is a risk factor for the development of ARF in nephrectomized patients.

Keywords: Renal insufficiency; nephrectomy; risk factors

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Introduction

Since 1963, radical nephrectomy has been the gold standard to treat localized renal tumors (1). However, the approaches to renal tumors has changed mainly due to new techniques involving advances in imaging that allow early

diagnosis (2). This increase has prompted discussions about the best method to preserve renal function in patients submitted to surgery.

Previous studies have shown significantly increased risk of renal failure, defined as creatinine serum concentrations greater than 2 mg/dL in patients submitted to radical

Table 1 Clinical and surgical data of patients submitted to open surgery and laparoscopic nephrectomy

Variable	n [%]
Neoplasia	47 [65]
Hypertension	35 [48]
Diabetes	15 [20]
Chronic kidney disease	10 [14]
Open surgery	50 [69]
Laparoscopic surgery	22 [31]

nephrectomy compared to those submitted to partial nephrectomy (3). On assessing renal function after kidney donation, recent studies show a higher risk of developing chronic kidney disease (CKD) compared to the general population (4). With 60% of patients developing renal dysfunction, several studies have attempted to identify risk factors for developing acute renal failure (ARF) after surgical procedures (5,6).

On considering the difficulties faced by hospitals including prolonged hospital stays with consequent high costs and by kidney disease patients such as worsening quality of life and work absenteeism, this study evaluates risk factors for the development of ARF in patients submitted to nephrectomy in a university hospital.

Methods

Patients and methods

Seventy-seven patients submitted to nephrectomy for both benign as malignant conditions were evaluated in the Urology Service of Hospital de Base in São José do Rio Preto, SP, from January 2015 to February 2016. Of the patients evaluated, five were excluded from the study due to lack of post-operative tests or loss of follow-up in the service. This study was approved by the Research Ethics Committee of the Medicine School in São José do Rio Preto (FAMERP-CAAE: 60833616.6.0000.5415).

Demographic (gender, age), clinical (type of neoplasm, diabetes, high blood pressure, CKD) and surgical data (time of anesthesia, open surgery or laparoscopy) were collected from the medical records of patients. The results of preoperative creatinine concentrations of 72 patients were analyzed and creatinine clearance was estimated using the Crockroft and Gault formula; the result was multiplied by

0.85 for female patients (7).

Postoperative analysis was based on creatinine levels measured between the 2nd and 30th days after surgery with the lowest value of creatinine found during this period being used. The criteria utilized to maintain patients in hospital for further creatinine measurements were based on the clinical condition of the patient, especially in cases of prior CKD. The mean follow-up until creatinine stabilization and the characterization of ARF was 30 days after the procedure.

Non-parametric tests (Spearman correlation) were used to investigate possible correlations in creatinine clearance after the procedure (qualitative data) and parametric tests (Pearson correlation) examined differences between preoperative and postoperative creatinine (quantitative data). All analyses were performed using the SPSS program version 23 for Windows (IBM, New York, United States). An alpha error of 5% was considered acceptable.

Results

The age of the patients submitted to nephrectomy ranged from 22 to 82 years (mean: 56±12 years) with 56% of the cases being male and 44% female. Of the 72 patients included in this study, 65% had renal neoplasms, 69% underwent open surgery and the mean surgical time, independent of the type of procedure, was 189 minutes (Table 1).

The mean anesthesia time of patients submitted to laparoscopy (238 min) was significantly greater than the time for open surgery (167 min: P=0.0005). The open surgery group of nephrectomized patients had higher rates of hypertension (58%) and diabetes (26%) (Table 2).

Of the 72 patients submitted to nephrectomy, 10 (13.8%) had a previous diagnosis of chronic renal failure (CRF). Furthermore, according to the Acute Kidney Injury Network (AKIN) criteria 8 used to classify renal function, renal failure was acute in 5 (50%) with 1 (10%) classified as stage I, none as stage II, and 4 (40%) as stage III.

Using the same criteria, of the 62 patients who had no diagnosis of CKD, 31 (50%) did not evolve with acute renal injury in the postoperative period, 30 (48%) progressed with Stage I ARF, 1 (16.1%) Stage II ARF and no patients developed Stage III ARF.

Among the patients who did not have preoperative CKD, 42 (67%) already had renal function below 90 mL/min/1.73 m² before the procedure. In patients with normal renal function prior to surgery, 65% (n=20)

Table 2 Comparison of demographic, clinical and operative variables of patients submitted to nephrectomy by open surgery and laparoscopy

Variable	Open surgery	Laparoscopic surgery	P value
Age (year) (mean \pm SD)	59 \pm 22	47 \pm 20	<0.0001*
Anesthetic time (min)	167	238	0.0005*
Side [n (%)]			
Right	26 [52]	10 [46]	0.7985**
Left	24 [48]	12 [54]	
Neoplasia [n (%)]	38 [76]	9 [40]	–
Hypertension [n (%)]	29 [58]	6 [27]	–
Diabetes [n (%)]	13 [26]	2 [9]	–
Preoperative CKD [n (%)]	6 [12]	4 [18]	–
Mean preoperative clearance (mL/min/1.73 m ²)	68	78	0.2094*
Mean postoperative clearance (mL/min/1.73 m ²)	54	65	0.0932*

*, student's t test; **, chi-square test. SD, standard deviation; CKD, chronic kidney disease.

Table 3 Correlation analysis to evaluate the postoperative clearance

Variable	P value	95% CI	r
Anesthesia time	0.3207	–0.1231 to 0.3472	0.1187
Open surgery	0.0992	–0.4148 to 0.04454	–0.1959
Laparoscopic surgery	0.0992	–0.04454 to 0.4148	0.1959
Right side	0.468	–0.3186 to 0.1546	–0.08688
Left side	0.468	–0.1546 to 0.3186	0.08688
Partial	0.9153	–0.2503 to 0.2262	–0.01276
Total	0.9153	–0.2262 to 0.2503	0.01276
CKD	<0.0001	–0.7117 to –0.3839	–0.5701
Diabetes	0.4455	–0.3226 to 0.1503	–0.09133
Hypertension	0.3681	–0.3373 to 0.1341	–0.1076
Neoplasia	0.0298	–0.4660 to –0.01903	–0.2562
Preoperative creatinine	<0.0001	–0.6318 to –0.2529	–0.4633
Postoperative creatinine	<0.0001	–0.7559 to –0.4625	–0.6313

CI, confidence interval; CKD, chronic kidney disease.

had reduced renal function after surgery.

Using the Spearman correlation, there were significant associations of postoperative creatinine clearance with CRF ($P<0.0001$), neoplasia ($P=0.0298$) and serum creatinine ($P<0.0001$) before the surgical procedure (Table 3). Moreover, a statistically significant correlation

was found on comparing preoperative and postoperative creatinine clearance ($P<0.0001$) (Figure 1).

Discussion

This study showed that the main risk factor for ARF in

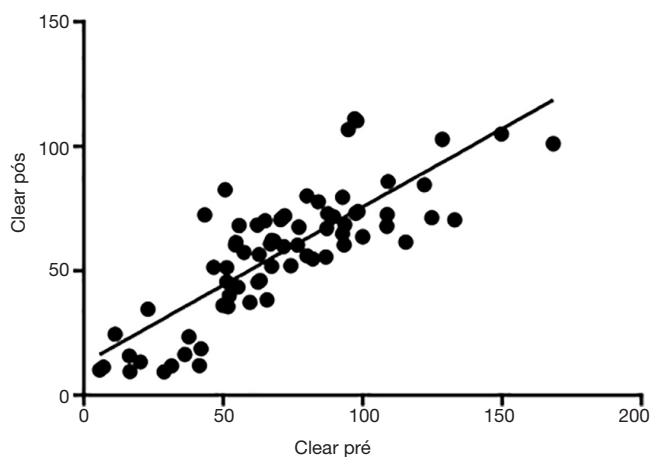


Figure 1 Analysis Pearson correlation between pre and postoperative clearance ($r=0.8116$; 95% CI, 0.7142–0.8782; $P<0.0001$).

nephrectomized patients was preexisting CKD. Although preoperative creatinine clearance was statistically significant, the correlation coefficient was not high. However, analysis of preoperative and postoperative creatinine clearance identified a notable positive correlation, confirming that preexistent CKD is a risk factor for postoperative deterioration of renal function.

The only risk factor associated with the development of acute kidney injury was preoperative hypertension (8). According to Naik *et al.* (9), chronic hypertension increases the risk of lability of the blood pressure in the preoperative period, thereby contributing to perioperative renal failure. These authors also report that more studies are needed to evaluate how control of the blood pressure before surgery influences CRF. However, in the current study, control of the preoperative pressure was not investigated.

Forbes *et al.* (10) reported surgical times that do not differ significantly from those found in this study. It is noteworthy that the current study was conducted in a university hospital with a medical residency program in urology that may have increased surgical time due to the learning curve. Surgical time did not correlate significantly with worsening renal function, i.e., the duration of anesthesia did not influence postoperative changes in renal function.

Examining renal dysfunction in general surgery, Gaber *et al.* (11) showed that 64% of patients had reductions in the glomerular filtration rate before surgery, thereby supporting the results obtained in this series, in which 67% of patients did not have a diagnosis of CKD before surgery, but had

some type of renal damage as shown by the creatinine clearance. As preoperative renal function is a predictor of postoperative ARF, our results reinforce the importance of the evaluation of renal function prior to nephrectomy. For Lane *et al.* (12) this clinical condition occurs in older patients with previous diseases, who often have preexisting CRF at the time of surgery.

Of the patients without preoperative renal injury, 65% had reduced postoperative clearance that did not drop to below 70 mL/min/1.73 m². Rajan *et al.* (13) found that 39% of his patients had ARF after partial nephrectomy. However, Thompson *et al.* (5) and Weight *et al.* (6) reported that 60% of patients had some type of kidney dysfunction after surgery. In this study, even with slightly higher rates in patients without impaired renal function before surgery, serious injuries in need of an intervention that might compromise the length of stay and patient survival were not observed. However, acute kidney injury should be avoided in patients undergoing radical nephrectomy with normal preoperative renal function because of the risk of progression to CKD (14). Renal injury after surgery can be minimized with appropriate procedures, including pre-operative care, the proper surgical technique and postoperative resuscitation (15,16).

One limitation of this study is the retrospective approach that has a selection bias due to non-randomization. Variables such as blood pressure were not monitored to verify the severity and control of hypertension. Anesthesia time is biased as the procedures were performed by surgeons at different stages of training, including residents, and so this time is probably longer than would be expected with just experienced surgeons. The number of cases of each type of procedure and respective diseases was not studied and so whether the type of procedure performed for a given disease influenced the postoperative renal function was not investigated.

In conclusion, impaired preoperative renal function is a risk factor for the development of ARF in patients submitted to nephrectomy in a university hospital.

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None.

Footnote

Conflicts of Interest: The authors have no conflicts of interest to declare.

Ethical Statement: This study was approved by the Research Ethics Committee of the Medicine School in São José do Rio Preto (FAMERP-CAAE: 60833616.6.0000.5415).

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