

# Laparoscopic nephrectomy for urolithiasis: when is better to avoid it.

## *Nefrectomia laparoscópica por nefrolitíase: quando é melhor evitar.*

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### A B S T R A C T

**Objective:** to investigate the risk factors for conversion to open surgery in laparoscopic nephrectomy (LN) for urolithiasis. **Methods:** we reviewed data on all patients over 18 years of age submitted to LN between January 2006 and May 2013 at our institution. We analyzed the Charlson's index, the ASA score, renal function by the equation and stage of MDRD (Modification of Diet in Renal Disease), preoperative computed tomography (CT) findings, complications by the Clavien-Dindo classification and conversion rate. We used logistic regression analysis to determine the risk factors for conversion. **Results:** eighty-four patients underwent LN, 16 (19%) sustaining conversion to open surgery due to the strong adhesion of the renal hilum to the adjacent organs. Other causes associated with conversion were excessive bleeding (n=6) and lesion of the large intestine (n=3). In the univariate analysis, previous renal surgery, perirenal fat blurring, renal abscess, perirenal abscess, pararenal abscess, fistula, adherence to the liver or spleen, and adherence to the intestine were associated with conversion. In the multivariate analysis, pararenal abscess and adherence to the intestine were significant risk factors for conversion. **Conclusion:** pararenal abscess and bowel adhesions demonstrated in the preoperative CT are risk factors for conversion to open surgery in LN due to urolithiasis.

**Keywords:** Nephrectomy. Laparoscopy. Risk Factors. Urolithiasis.

### INTRODUCTION

The prevalence of kidney calculi is approximately 8% of the population and its incidence is increasing over the past two decades in both men and women of different age groups<sup>1</sup>. Renal calculus disease is a benign pathology, but can cause progressive loss of renal function, end-stage kidney disease and ultimately death<sup>2</sup>. Treatment aims to preserve renal function and to eradicate kidney calculi. However, nephrectomy may be necessary in cases of severe urinary infection or chronic pain in a kidney with a poor function<sup>3</sup>.

Laparoscopy is considered the gold standard approach for nephrectomy due to less postoperative pain, short recovery and better cosmetic outcomes. However, the massive inflammatory process that sometimes is associated to complicated calculus disease

causes technical difficulties, owing to the presence of a significant fibrotic component. The ultimate presentation in this scenario is xanthogranulomatous pyelonephritis (XGP), accompanied by perirenal fat proliferation that infiltrates the renal fossa structures, including the renal hilum<sup>4</sup>. Owing to its severe inflammatory nature, distinct surgical complications are expected from those found in nephrectomy for donation or kidney cancer<sup>5</sup>. Furthermore, some patients present with adverse conditions, such as renal abscess, renocutaneous fistula and visceral or intestinal adhesions. The conversion rate to open procedure is expected to be higher in patients with renal calculus comparing with other affections<sup>6</sup>.

In this retrospective study, we searched for preoperative predictive factors for conversion to open surgery in laparoscopic nephrectomy (LN) for urolithiasis.

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## METHODS

We retrospectively evaluated all consecutive patients older than 18 years of age submitted to LN for urolithiasis from January 2006 to May 2013 in a tertiary reference center. Nephrectomy was accomplished due to pain in excluded kidneys or severe urinary infection. Initial surgical approach was proposed by the surgeon and discussed with the patient. Informed consent was obtained from all patients. We obtained the approval of the local Institutional review board for the study protocol.

This work was approved by the Institutional Ethics Committee with the following reference number: 1,905,989.

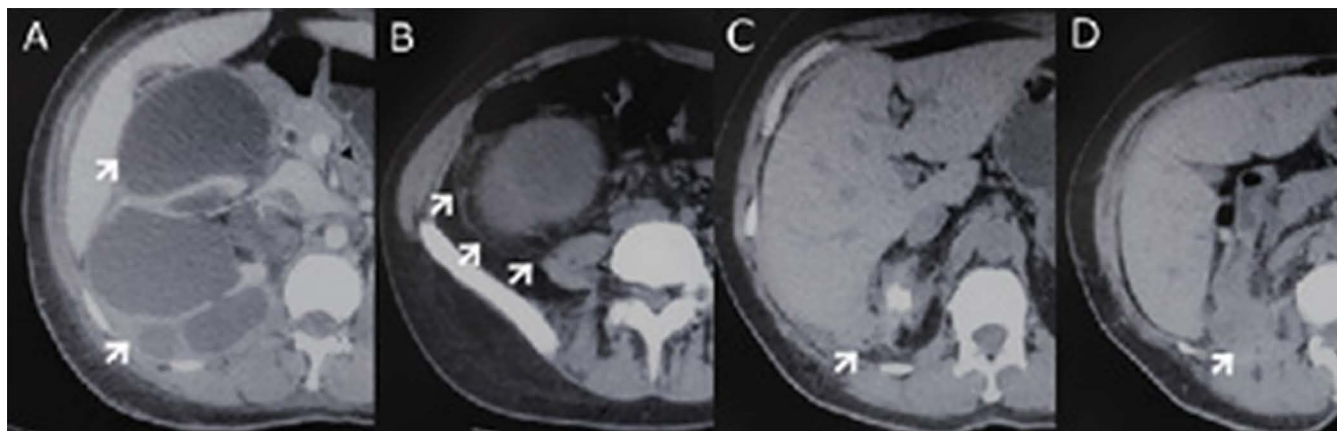
### Preoperative assessment

We assessed renal function by the equation of the Modification Diet for Renal Disease (MDRD)<sup>7</sup> for estimated glomerular filtration rate and staged according to National Kidney Foundation. We estimated the split renal function with 99m technetium dimercapto-succinic acid renal scintigraphy (99mTc-DMSA). We evaluated comorbidities with the Charlson Index and the American Society of Anesthesiologists (ASA) score<sup>8</sup>. We carried out computed tomography scans preoperatively in all patients.

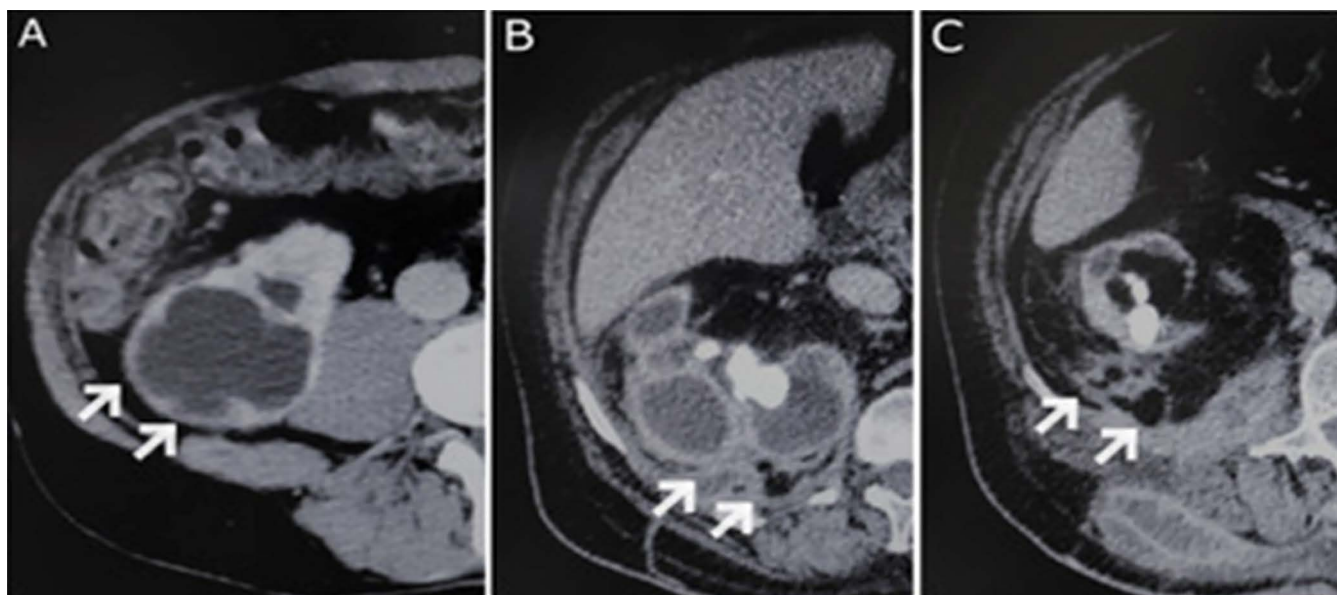
Findings of hydronephrosis, fat stranding, adherence to surrounding structures (Figure 1) and abscess (renal, perirenal and pararenal) (Figure 2) were based on the radiologists report.

### Operative technique

Residents performed the procedures under direct supervision of experienced laparoscopic surgeons. We carried out LN through a transperitoneal approach. Under general anesthesia, we positioned patients in a 45-degree supine-oblique position. We created pneumoperitoneum with CO<sub>2</sub> up to 15mmHg intra-abdominal pressure. We used four trocars (two 10mm and two 5mm). On the right side, we positioned an extra trocar in the epigastric region to move the liver cranially and adequately expose the right kidney. We dissected the kidney and perirenal fat outside the Gerota fascia<sup>5</sup>. We approached the renal hilum as close as possible to the inferior vena cava on the right side, and to the aorta on the left side. We clipped the renal arteries and veins with Hem-o-lock® clips and divided them. We clipped the ureter and sectioned it close to the iliac vessels. We removed the specimen fragmented in a bag through the umbilical incision or undivided through a suprapubic incision. We sent the specimen for pathologic analysis in all cases.



**Figure 1.** Tomographic findings of the kidneys affected by calculi and the spectra of the inflammatory process: A) hydronephrosis caused by an obstructing calculus; B) perirenal fat infiltration due to severe inflammatory infiltration; C) adherence to liver; D) adherence to the psoas muscle.



**Figure 2.** Tomographic findings showing abscess formation due to kidney inflammatory disease: A) renal abscess; B) perirenal abscess; C) pararenal abscess.

### Postoperative complications

Postoperative complications were reported according to the Clavien-Dindo classification<sup>9</sup>.

### Statistical analysis

We analyzed the categorical variables using the Chi-square and the Fisher's exact test and continuous ones using the Student's t-test and analysis of variance (ANOVA). We performed a logistic regression analysis to evaluate the association between clinical and pathological data and the risk of conversion to open surgery. We conducted statistical analyzes with the aid of the SPSS Statistics v16.0 (Chicago, SPSS Inc.).

## RESULTS

Eighty-four patients with a poor functioning kidney associated to pain or severe infection underwent nephrectomy in our Institution (Table 1) in the study period. The main tomographic findings were hydronephrosis (71.4%), fat stranding (63%) and adherence to liver/spleen (29.6%).

**Table 1.** Preoperative data.

Preoperative data	n (%)
Gender (female)	67 (79.7)
Age (mean±SD)	47.8±14.2
BMI (mean±SD, kg/m <sup>2</sup> )	26.6±5.5
Prior renal surgery	37 (44)
Renal size (mean±SD, cm)	11.7±3.83
Left kidney	44 (52.3)
DMSA renal scan (mean±SD, %)	8±9.8
MDRD (mean±SD, ml/min/1.73m <sup>2</sup> )	69.45±28.03
Charlson index (mean±SD)	1.26±1.9
ASA score	
1	22 (26.2)
2	52 (61.9)
3	8 (9.5)
4	2 (2.4)
Staghorn calculus	47 (55.9)
Tomographic findings	
Hydronephrosis	60 (71.4)
Fat stranding	53 (63)
Renal abscess	15 (17.8)
Perirenal abscess	7 (8.3)
Pararenal abscess	3 (3.5)
Adherence to liver/spleen	25 (29.6)
Adherence to bowel	20 (23.8)
Adherence to muscle	16 (19)

BMI= body mass index; SD= standard deviation; MDRD= modification of diet in renal disease formula; DMSA= dimercapto-succinic acid; ASA= American Society of Anesthesiologists.

Conversion rate was 19% (16 of 84 patients). The main cause of conversion was inadequate exposure of the renal hilum due to severe adhesion and inflammation, seen in all converted cases. Other causes for conversion included excessive bleeding during the operation (6/16, 37.5%) and large intestinal injury (3/16, 18.8%).

Complications according to the Clavien classification are summarized in table 2. Two vena cava injuries were repaired by running laparoscopic suture. Open splenectomy was performed in the immediate postoperative period in one patient due to a splenic laceration. There were five intestinal injuries: two duodenal, one repaired laparoscopically and other converted to open procedure, one colonic and one small bowel injuries that resulted in conversion. One patient died due to unrecognized colonic injury and peritonitis. Table 3 shows the pathological reports.

**Table 2.** Complications according to the Clavien classification.

Clavien classification	n (%)
I	62 (73.8)
II	11 (13.1)
III a	3 (3.5)
III b	1 (1.2)
IV a	5 (5.9)
IV b	1 (1.2)
V	1 (1.2)

**Table 3.** Pathology report.

Pathology report	n (%)
Xanthogranulomatous pyelonephritis	16 (19)
Atrophy	18 (21.4)
Chronic pyelonephritis	32 (38)
Pyonephrosis	10 (11.9)
Nephrocalcinosis	8 (9.5)

In the univariate analysis, conversion was significantly associated to prior renal surgery (68.7% vs. 38.2%,  $p=0.043$ ), perirenal fat stranding

(97.3% vs. 55.8%,  $p=0.004$ ), renal abscess (37.5% vs. 13.2%,  $p=0.03$ ), perirenal abscess (25% vs. 4.4%,  $p=0.023$ ), pararenal abscess (18.7% vs. 0%,  $p=0.006$ ), fistula (18.7% vs. 0%,  $p=0.006$ ), adherence to liver or spleen (56.2% vs. 23.5%,  $p=0.015$ ) and adherence to bowel (75% vs. 11.7%,  $p<0.0001$ ) (Table 4).

In the multivariate analysis, only pararenal abscess ( $p=0.0052$ ) and adherence to bowel ( $p<0.0001$ ) were significant risk factors for conversion (Table 5). Postoperative hospital stay was relatively higher in the conversion group ( $5.4\pm 3.1$  vs.  $3.19\pm 2,3$  days,  $p=0.005$ ).

## DISCUSSION

Laparoscopy is the procedure of choice for performing nephrectomy<sup>10</sup>. Nowadays, the vast majority of nephrectomies are performed for donation or treatment of renal cancer<sup>10,11</sup>. Nephrectomy due to complications of urolithiasis is performed in a few situations, including kidneys with poor function associated to chronic pain, symptomatic or recurrent infections, abscess or fistulae formation and suspect malignant degeneration<sup>3</sup>.

LN due to urolithiasis is a challenging procedure, requiring a skillful surgical team. The inflammatory process creating a toxic fat involves the renal hilum, leading to a very difficult dissection of the renal artery and vein. Moreover, bulky adenopathy, adhesion to bowel, liver, spleen, pancreas or muscle are frequent. *En block* clamping or initial clamping of the renal vein are eventually required maneuvers to control the renal hilum, diverting from standard nephrectomy. On certain occasions, it is impossible to find a cleavage plane between the large vessels and the urinary tract, forcing the surgeon to leave patches of kidney tissue adhered to these structures. On the right side, the difficulty is even higher due to the nearby vena cava and the duodenum.

**Table 4.** Univariate analysis of risk factors for conversion in laparoscopic nephrectomy for urolithiasis.

	Conversion n(%)	Pure laparoscopy n(%)	p-value
Female	13 (81.2)	54 (79.4)	1.000
Age >70 years	1 (62)	2 (3.0)	0.474
BMI $\geq$ 30kg/m <sup>2</sup>	2 (12.5)	18 (26.4)	0.336
Prior renal surgery	11 (68.7)	26 (38.2)	0.043
DMSA <20%	15 (93.7)	63 (92.6)	1.000
Charlson >2	7 (43.7)	16 (23.5)	0.125
ASA score			0.557
1	4 (25.0)	18 (26.4)	
2	9 (56.2)	43 (63.3)	
3	3 (18.7)	5 (7.3)	
4	0 (0.0)	2 (3.0)	
Kidney size =12cm	7 (43.7)	17 (25)	0.217
Tomographic findings			
Hydronephrosis	11 (68.7)	49 (72.0)	0.767
Fat stranding	15 (93.7)	38 (55.8)	0.004
Renal abscess	6 (37.5)	9 (13.2)	0.033
Perirenal abscess	4 (25.0)	3 (4.4)	0.023
Pararenal abscess	3 (18.7)	0 (0.0%)	0.006
Fistula	3 (18.7)	0 (0.0%)	0.006
Adherence to liver/spleen	9 (56.2)	16 (23.5)	0.015
Adherence to bowel	12 (75.0)	8 (11.7)	<0.0001
Adherence to muscle	5 (31.2)	11 (16.1)	0.175
Pathological diagnosis			
Xanthogranulomatous Pyelonephritis	6 (37.5)	10 (14.7)	0.105
Atrophy	2 (12.5)	16 (23.5)	0.449
Chronic Pyelonephritis	6 (37.5)	26 (38.2)	0.711
Pyonephrosis	2 (12.5)	8 (11.7)	0.165
Nephrocalcinosis	2 (12.5)	6 (8.9)	0.105

SD= standard deviation; MDRD= modification of diet in renal disease formula; ASA= American Society of Anesthesiologists.

**Table 5.** Multivariate analysis of risk factors for conversion in laparoscopic nephrectomy for urolithiasis.

Risk factors	Chi-square	p-value
Fat stranding	0.121	0.728
Renal abscess	0	0.9996
Perirenal abscess	0.016	0.8978
Pararenal abscess	7.808	0.0052
Adherence to liver/spleen	3.007	0.0829
Adherence to bowel	30.424	<0.0001

In our series, we observed two cases of duodenum injury and two cases of vena cava tearing repaired by laparoscopic suture. Such technical difficulties lead many urologists to question the laparoscopic approach in such cases<sup>12,13</sup>. In this scenario, the literature suggests that LN due to calculi and inflammatory disease should be performed by approaching the kidney from outside the Gerota fascia, leading to a safer procedure<sup>14,15</sup>.

Conversion rate is still higher than the one observed in LN for other conditions. Zelhof *et al.*, in a study of 142 cases selected from all the nephrectomies performed in the United Kingdom due to benign conditions, demonstrated higher conversion rates to open procedure in patients with renal calculi than for radical nephrectomy for T1 disease<sup>16</sup>. A recent retrospective study with 96 laparoscopic nephrectomies for calculus disease evidenced a conversion rate of 7.2%<sup>17</sup>. Conversion to open procedure was necessary because it proved impossible to dissect the renal hilum due to xanthogranulomatous pyelonephritis (n=4) or major associated lesions (n=3). In other recent prospective study with 44 patients submitted to LN for benign non-functioning kidney diseases, six (13.6%) were converted to open surgery due to vascular lesions, malfunctioning of surgical devices and no localization of the atrophic kidney<sup>15</sup>. Our study reports a 19% (16/84) conversion rate in nephrectomies exclusively for urolithiasis. In all converted cases, the appropriate access to the renal hilum was hampered due to the intense inflammatory process. Conversion to open nephrectomy also results in longer hospital stay (5.4±3.1 vs. 3.19±2.3 days, p=0.005), highlighting the importance of choosing the proper access prior to nephrectomy.

There are few evidences in the medical literature establishing predictive factors for open conversion in LN. Angerri *et al.* showed that

extensive areas of pyelonephritis are a major risk for conversion<sup>17</sup>. Rassweiler *et al.* reported seven conversions to open procedures in a multicentric study with 482 LN, of which two involved an XGP kidney<sup>18</sup>. In our series, there were more cases with XGP in the conversion group (25.0% vs. 14.7%; p=0.105), however there was no significant difference between groups regarding pathological findings.

Previous renal ipsilateral surgery increases difficulty due to anatomical changes in already operated kidneys, in addition to scarring processes and adhesions to nearby tissues<sup>6</sup>. In our study, cases with prior renal surgery were more frequent among converted procedures but this fact was not significant in the multivariate analysis.

Preoperative enhanced CT scan plays an important role in inflammatory kidney diseases, determining the extension of the inflammatory process. The pattern of differential enhancement in these cases reflects the underlying pathophysiology of tubular obstruction caused by inflammatory debris within the lumen, interstitial edema, and vasospasm<sup>19</sup>. Perirenal fat infiltration occurs when the inflammation of the renal parenchyma is severe and the inflammatory infiltration spreads beyond the renal capsule to the perirenal fat. Renal abscess formation, perinephric abscess formation (perirenal and pararenal) and pyonephrosis indicate a more severe inflammatory status, resulting in fistulae and adherences to adjacent structures. Hydronephrosis is caused by an obstructing calculus. These tomographic findings predict an upcoming complex procedure. Herein we demonstrated the key importance of tomographic features in predicting conversion to open nephrectomy. In univariate analysis, fat stranding, renal, perirenal and pararenal abscess, fistula and adherences to adjacent structures were significantly more frequent in the conversion group.

Multivariate analysis revealed that pararenal abscess and adherence to the bowel were significant risk factors for conversion to open procedure. All patients who presented a pararenal abscess on preoperative tomography had their procedures converted to open access, which gives this parameter statistical significance even with a reduced number (n=3).

There are some limitations of our study, such as the small number of cases and its retrospective nature. However, as far as we know, this is the first report to look for preoperative predictive factors for

conversion from laparoscopic to open nephrectomy due to calculous disease. A prospective multicentric study with a large number of patients might confirm our data.

In conclusion, conversion rate for LN due to urolithiasis was 19% in our series. Risk factors for conversion to open nephrectomy were pararenal abscess and adherence to the bowel as identified in preoperative CT. In these cases, the procedure is associated with an increased degree of technical difficulty. Therefore, initiating nephrectomy by the open access should be considered.

## R E S U M O

**Objetivo:** investigar os fatores de risco de conversão para cirurgia aberta na nefrectomia laparoscópica (NL) para urolitíase. **Métodos:** foram revisados os dados de todos os pacientes maiores de 18 anos de idade submetidos à NL entre janeiro de 2006 e maio de 2013 em nossa Instituição. Índice de Charlson, escore ASA, função renal pela equação e estágio de MDRD (Modification of Diet in Renal Disease), achados de tomografia computadorizada (TC) pré-operatória, complicações pela classificação de Clavien-Dindo e taxa de conversão foram analisados. Determinaram-se os fatores de risco para conversão por meio de regressão logística. **Resultados:** oitenta e quatro pacientes foram submetidos à LN, sendo que 16 (19%) tiveram seu procedimento convertido para cirurgia aberta devido à forte aderência do hilo renal aos órgãos adjacentes. Outras causas associadas à conversão foram sangramento excessivo (n=6) e lesão do intestino grosso (n=3). Na análise univariada, cirurgia renal prévia, borramento da gordura perirrenal, abscesso renal, abscesso perirrenal, abscesso pararenal, fistula, aderência ao fígado ou baço e aderência ao intestino foram associados à conversão. Na análise multivariada, abscesso pararenal e aderência ao intestino foram fatores de risco significativos para a conversão. **Conclusão:** abscesso pararenal e aderência ao intestino demonstrados na TC pré-operatória são fatores de risco de conversão para cirurgia aberta em LN por urolitíase.

**Descritores:** Nefrectomia. Laparoscopia. Fatores de Risco. Nefrolitíase.

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