Pascal *et al. BMC Urology* (2024) 24:229
https://doi.org/10.1186/s12894-024-01620-7

BMC Urology

RESEARCH Open Access

Open versus mini-invasive partial and radical nephrectomy complications: results from the French national health database

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Abstract

Background Laparoscopic surgery is associated with a lower morbidity than open surgery. No recent data compared kidney cancer surgery in the French population using the National Health Insurance database (PMSI-MCO).

Aims We explore and compare the surgical morbidity rates between laparoscopic and open laparotomy for kidney cancer.

Methods The initial length of stay and complications parameters during the three postoperative months were described for renal cancer in every French center in 2018. We compared Relative Risks (RR [95% CI]) between laparoscopic and open surgery for both radical and partial nephrectomy.

Results Among 8,162 patients, 3,525 had a radical nephrectomy, 978 open, 2,547 laparoscopic surgeries; 4,637 patients had partial nephrectomies, 1,778 open 2,859 laparoscopic surgeries. For radical surgery, the most common complications were urinary infections (7.8%), acute renal failure (8.9%), sepsis (8.4%), bleeding (9.3%), and postoperative anemia (5.9%); the RR for laparoscopic *versus* open surgery were respectively 0.68 [0.54;0.86], 0.71 [0.57;0.88], 0.69 [0.55;0.86], 0.83 [0.66;1.03], 0.56 [0.43;0.73]. For partial nephrectomies, the most common complications were urinary infections (7.7%), bleeding (11.6%), and postoperative anemia (5.8%), with RR of 0.71 [0.58;0.87], 0.61 [0.52;0.71], and 0.64 [0.51;0.81]. The mean length of stay was 7.7 for open radical nephrectomy, 6.3 for laparoscopic radical nephrectomy, 7.5 for open partial nephrectomy, and 5 for laparoscopic partial nephrectomy.

Conclusions The laparoscopic approach had fewer postoperative complications and a shorter length of stay than open surgery for partial and radical nephrectomy. The PMSI analysis provided an exhaustive description of surgical practice for kidney cancer and surgical complications in France.

Clinical trial number Not applicable.

Keywords Complications, Kidney, Laparoscopy, Neoplasia, Surgery

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Background

Kidney cancer is the world's fourteenth most common solid tumor [1]. Historically, kidney tumors were managed by removing the cancer in open surgery [2]. Surgical excision of the tumor or the entire kidney in non-metastatic patients remains the standard of care [3]. In large data series, overall complications range from 12 to 36% [4–8], regardless of the surgical approach.

Surgical complications delay hospital discharge and increase the expense of care. Over time, renal surgery techniques for cancer have been improved from the first description of open radical nephrectomy by Robson in 1963 [2]. In 1991, Clayman et al. described laparoscopic radical nephrectomy [9], and Winfield performed the first laparoscopic partial nephrectomy for benign disease in 1992 [10]. Mastering laparoscopy led urologists to prefer this approach when possible, lowering the risk of complications for the same oncology outcomes [3, 4]. Nevertheless, these studies are conducted mainly in expert centers; to our knowledge, no study has ever been conducted in an entire country population for one year about open and laparoscopic approaches detailing all types of rehospitalization-related complications.

In this context, the use of the French National Health Insurance Database, PMSI MCO (Programme de Médicalisation des Systèmes d'Information - Médecine, Chirurgie, Obstétrique), is particularly relevant. This centralized medico-economic database covers all private and public hospital activities in France and is the basis for hospital billing and reimbursement. It contains comprehensive and coded information on pathologies, treatments, and complications for each patient's hospitalization since 1991 for every public center and 1997 for every private center. In contrast, other countries like Germany or the United States only include in-hospital patients based on their healthcare insurance. The PMSI MCO database is not only exhaustive and reliable but also provides a standardized format for data collection, enabling robust and large-scale analyses of clinical outcomes across various healthcare settings.

Hospitalizations in the PMSI are classified under a "Groupe Homogène de Malades" (GHM), which is akin to the American model of Diagnosis-Related Groups (DRGs). Both the GHM and DRG systems categorize hospital stays into clinically similar groups and expect them to use the same level of hospital resources, providing detailed medical and cost information essential for billing purposes. GHS in PMSI further allows for a systematic approach to evaluating hospital performance and patient outcomes, adding another layer of utility for research purposes.

For an observational study focusing on surgical outcomes, the PMSI MCO offers an invaluable data source to document and compare the morbidity associated with radical and partial kidney cancer surgeries performed via open and laparoscopic approaches. By leveraging this rich dataset, which includes variables such as surgical techniques, complication rates, and GHS classifications, we can conduct an in-depth analysis of the entire French population scale in real-life settings. This approach allows for a more comprehensive understanding of surgical outcomes outside specialized centers, ultimately contributing to better informing patients preoperatively and guiding clinical decision-making.

Table 1 CIM-10 corresponding codes for complications and CCAM corresponding codes for surgeries

Complications	code CIM-10
Wound complication	L022, K432, T8138, T8130, S308
Urinary infection	N10, N410, N390
Pulmonary infection	J150-159, J180-189
Acute renal failure	N17, N990, R392
Venous thrombosis	I80, I26
Bowel occlusion	K913, K560
Sepsis	A40, A41, R65, R572
Peritonitis	K65
Renal abscess	N151
Bleeding	S3700, T810, R571
Postoperative anemia	D500, D62
Pneumothorax	S2760
Renal fistula	N288
False aneurysm	I722
Type of surgery	**CCAM codes**
Laparoscopic radical nephrectomy	JAFC006, JAFC010, JAFC019
Laparoscopic partial nephrectomy	JAFC005
Open radical nephrectomy	JAFA023, JAFA002, JAFA010, JAFA009, JAFA029
Open partial nephrectomy	JAFA019, JAFA030, JAFA008, JAFA024

Materials et methods

Population

We included all adult patients (>20 years) operated between January 1 and December 31, 2018, with newly diagnosed renal tumors (International Classification of Diseases (ICD)-10, code: C64) and hospitalized for surgical treatment in all French public or private centers. From the PMSI-MCO, we worked with the "Classification commune des actes médicaux" (CCAM), a complementary coding list for therapeutic acts included in the database, to define four groups: open radical nephrectomy (ORN), laparoscopic radical nephrectomy (LRN), open partial nephrectomy (OPN), and laparoscopic partial nephrectomy (LPN), (Table 1). Robotic-assisted laparoscopy was not separated from other laparoscopies because no distinct code was available in 2018.

The exclusion criteria were morbid surgeries such as cava thrombectomy, thoracophrenolaparotomy or binephrectomy, metastatic patients, and simple nephrectomy.

In addition, nephrectomy associated with ureterectomy was also excluded, as it was upper tract urothelial carcinoma.

Morbidity evaluation

Morbidity was determined with complications related to surgery: wound complication, urinary infection, pulmonary infection, acute renal failure, bowel occlusion, sepsis, peritonitis, renal abscess, bleeding, postoperative anemia, pneumothorax, renal fistula, false aneurysm as well as venous thrombosis. The initial hospital length of stay was also sorted by surgery type.

Wound complications were defined as wound infections and eventrations; anemia as hemoglobin levels lower than the standard for age and sex (men < 140 g/L, women < 130 g/L); bleeding as any hemorrhage or hematoma following surgery; sepsis as inflammatory syndrome from any cause; acute renal failure was coded according to KDIGO criteria [11] independently of the severity; venous thrombosis as deep venous thrombosis or pulmonary embolism.

Statistical analysis

Complications associated with the two surgical procedures are described by percentages and compared between laparoscopic and open nephrectomy by relative risks (RR) and their 95%CIs. Fisher exact p values were calculated for complications with zero frequencies when RRs could not be calculated. Statistical analyses used SAS, version 9.4 (SAS Institute Inc., Cary, NC, USA).

Table 2 Time of hospital stay by type of surgery

Type of surgery	ORN	LRN	OPN	LPN
Mean length of stay	9.7	6.3	7.5	5

Results

In 2018, 8,162 patients underwent renal surgery for kidney cancer in France. We identified 3,525 (43%) radical nephrectomies, with 2,547 (72%) LRN and 978 ORN, and 4,637 (57%) partial nephrectomies, with 2,859 (62%) LPN and 1,778 OPN. Initial hospital stay was shorter for LPN, with a mean length of stay of 5 days and 9.7 days for ORN (Table 2).

Radical nephrectomy

The most frequent complications were urinary infections (7.8%, 6.9%, and 10.1%, respectively for overall, LRN, and ORN), acute renal failure (8.9%: 8.0%, 11.2%), sepsis (8.4%: 7.5%, 10.9%), bleeding (9.3%: 8.8%, 10.6%) and post-operative anemia (5.9%: 4.8%, 8.6%) (Fig. 1).

The risk of complications with LRN was lower than with ORN ($p < 0.05$): for urinary infections with RR = 0.68 [0.54;0.86]; acute renal failure, 0.71 [0.57; 0.88]; bowel occlusions, 0.61 [0.39; 0.96]; sepsis, 0.69 [0.55; 0.86]; postoperative anemia, 0.56 [0.43; 0.73]; with a trend for bleeding 0.83 [0.66; 1.03] (Fig. 1).

Peritonitis was more frequent with LRN than ORN, with 18 (0.7%) *versus* zero cases ($p = 0.006$).

Partial nephrectomy

The predominant complications were urinary infection (7.4%: 8.9%, 6.4% overall and for OPN, LPN), acute renal failure (4.9%: 6.9%, 3.7%), sepsis (7.7%: 10.2%, 6.1%),

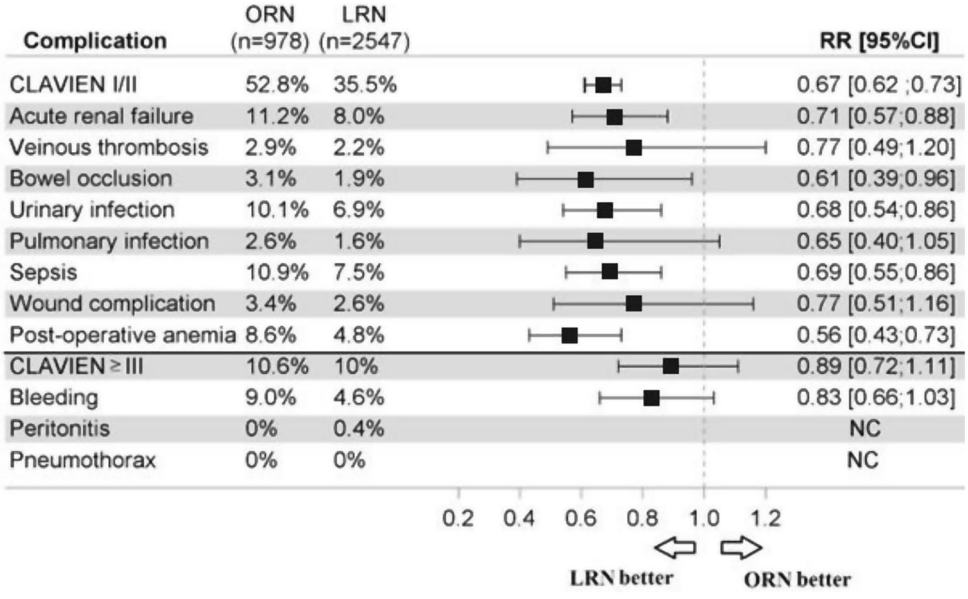

Fig. 1 Complications following open radical nephrectomy and laparoscopic radical nephrectomy in France in 2018. ORN: Open radical nephrectomy; LRN: Laparoscopic radical nephrectomy; RR[95%CI]: 95% Confidence intervalle Relative risk

bleeding (11.6%: 15.3%, 9,3%), and postoperative anemia (5.8%: 7.5%, 4.8%) (Fig. 2). All complications with LPN were lower than with OPN ($p<0.05$) except for false aneurysms with RRs 0.69 [0.42; 1.13] and venous thrombosis 0.76 [0.49; 1.19]. Pneumothorax was more frequent in OPN, with zero cases in LPN ($p<0.001$).

We found no peritonitis in patients undergoing a partial nephrectomy.

Discussion

This manuscript provides data from daily surgical practice in France for the 3-month postoperative complication rates for non-metastatic cancer renal surgery. Literature often came from leading expert centers where laparoscopic surgeries are well-mastered. As our data include all renal surgeries in reference centers, community hospitals, and public and private practices, we provide real-life in-hospital postoperative complication rates.

We confirmed that the laparoscopic approach decreased morbidity and length of stay compared to open surgery for radical and partial nephrectomy in renal tumors. For radical and partial nephrectomies, laparoscopy provided statistically significant lower complication rates for urinary infection, acute renal failure, bowel occlusion, sepsis, and postoperative anemia.

Regarding bleeding, results are quite heterogeneous in the literature, with 1.14 to 11.9% for LRN and 2.09 to 19% for ORN [6, 12–14]. For partial nephrectomies, the literature shows bleeding and anemia from 5.8 to 9% for laparoscopy and 2 to 12.7% for open surgeries [4–6, 12]. Stang and Buchel reported that for partial nephrectomies, laparoscopy, and open combined, 18.5% had bleeding or anemia. For ORN and LRN, the rates were 19.0% and 11.9%, a statistically significant difference with an RR of 0.69 (0.61–0.78) [15]. Our incidences were similar, with 11.6% for partial nephrectomy and 10.6% and 8.8% for ORN and LRN, respectively, with a lower incidence for laparoscopy than open surgery. Comparisons between studies should be made carefully as postoperative anemia and bleeding definitions have variable definitions and are often confused.

Renal failure varied from 1.9 to 14% in prolonged ischemia with eGFR<45mL/min for partial nephrectomy and up to 35% for radical nephrectomy [16, 17]. We recorded 8.9% of renal failure in patients undergoing radical nephrectomy and 4.9% for partial nephrectomy. Our results showed that LRN and LPN patients had better postoperative renal function than those treated with open nephrectomy. In contrast, no difference was found in clinical studies for open vs. laparoscopic partial nephrectomy [4, 5]. However, renal failure was coded in the ICD-10 as all acute renal failure stages with only one code. Furthermore, the literature's criteria and the failure cutoffs were very heterogeneous.

Peritonitis occurred only with LRN (0.7%) in our study and was more frequent than open surgery ($p=0.006$). We hypothesized that bowel wounds may be overlooked during laparoscopy when trocars or Veress needles are introduced in the peritoneal cavity, followed by a coagulator [18].

Patients who underwent a laparoscopic approach were less exposed to urinary infections in the French population. The literature prevalence of urinary infection was

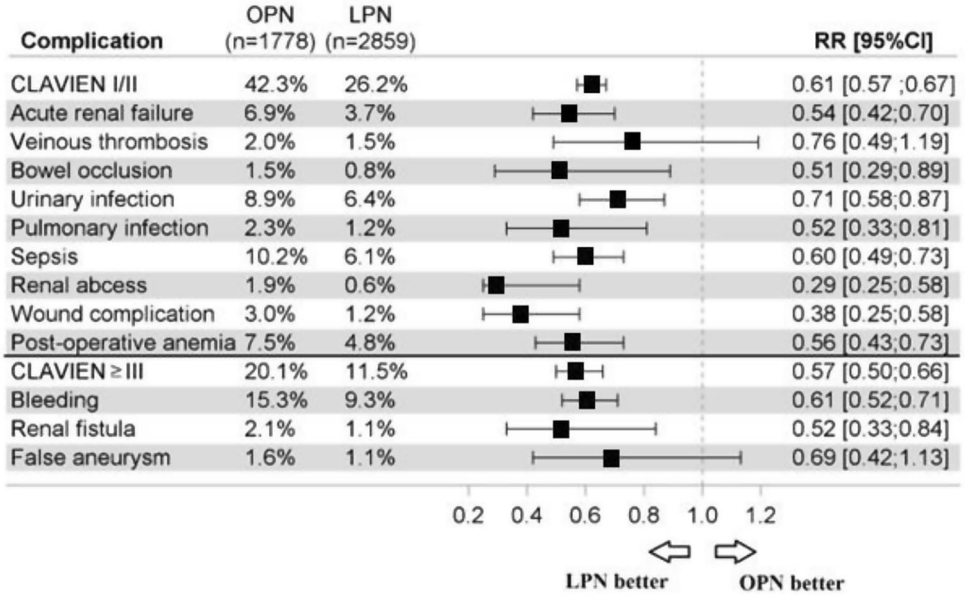

Fig. 2 Complications following partial nephrectomy open partial nephrectomy and laparoscopic partial nephrectomy in France in 2018. OPN: Open partial nephrectomy; LPN: Laparoscopic partial nephrectomy; RR [95%CI]: 95% confidence interval Relative risk

around 0.6 to 11.8% [6, 19] for radical nephrectomy and 0.5 to 7.9% [6, 15, 19, 20] for partial nephrectomy, and these are similar to our findings of 7.8% and 7.4% respectively, without accounting for laparoscopic or open approaches.

There is no equivalent in the literature between the rate of sepsis as defined in our study and that of the literature. The different types of infections and inflammatory syndromes are poorly defined. However, these complications should not be neglected and are statistically significantly more frequent in open surgery in our data.

Compared to the literature, the overall rate of pneumothorax was low, with 1–4.6% [6, 15, 17, 21, 22] for partial nephrectomy and 0.76–2.6% [14, 17] for radical nephrectomy. Our study recorded just 18 such complications only in OPN, statistically significantly higher than for LPN with zero recorded ($p<0.001$).

Table 3 Comparison between complications of partial and radical nephrectomy between PMSI-MCO in 2018 and other studies

Complications	French PMSI data	Other studies data
Veinous thrombosis		
Laparoscopic PN	1.5%	1.7% [20]
Open PN	2%	1.7-2% [6, 20]
RN*	2.2–2.9%	1.1% [20]
Bleeding		
Laparoscopic PN	9.3%	5.8-9% [5, 6, 12, 15, 20]
Open PN	15.3%	2-12.7% [4–6, 12, 15, 20]
Laparoscopic RN	8.8	1.14–11.9% [6, 12–14]
Open RN	10.6%	2.09-19% [6, 12–14]
False aneurysm		
Laparoscopic	1.1%	0.42–3.6% [4, 24, 26, 30]
Open	1.6%	0.06–5.5% [4, 24, 26, 30]
Urinary fistula		
Laparoscopic	1.1%	0.37-4% [5, 15, 20, 26]
Open	2.1%	0.87–4.3% [5, 15, 20, 24]
Urinary infections*		
PN	6.4–8.9%	0.51–7.9% [6, 19, 20, 24]
RN	6.9–10.1%	0.57–11.8% [6, 15, 19, 20]
Wound complications		
Laparoscopic PN	1.2%	0.53–0.8% [15, 20, 26]
Open PN	3%	1-3.21% [6, 15, 20, 24, 26]
Laparoscopic RN	2.6%	0% [6]
Open RN	3.4%	1.33% [6]
Occlusions		
Laparoscopic PN	0.8%	0-0.8% [6, 20, 24]
Open PN	1.5%	0.8–2.1% [6, 20, 24]
Laparoscopic RN	1.9%	0% [6]
Open RN	3.1%	0.57% [6]
Peritonitis*		
PN	0%	0.5% [17]
RN	0-0.4%	1.3% [17]
Pulmonary infection*		
PN	1.2–2.3%	0.79–4.3% [17, 24, 26]
RN	1.6–2.6%	0.76–2.6% [17, 20]

PN: Partial nephrectomy; RN: Radical nephrectomy; * laparoscopy and open approaches not separated

Jordan et al. showed statistically significant differences in venous thrombosis between open and laparoscopic approaches, 2.0% vs. 0.8% $p<0.001$ [23]. The rates were not dissimilar to our study, with an overall rate of 2%. However, the rates did not differ between open and laparoscopic surgeries.

According to the surgical approach for partial nephrectomy, we found a similar frequency of a false anevrysm and renal fistula. This result was relevant to the literature, showing no differences [5, 15, 22–24]. Nevertheless,

Conversely, wound complications, pulmonary infection, bowel occlusion, renal abscess, and renal fistula were less frequent in LPN than in OPN, with statistically significant differences, following the literature [4, 5, 15, 20, 24, 25] (Table 3).

Our analysis has a few limitations. In France in 2018, 72% of radical nephrectomies and 62% of partial nephrectomies were performed by laparoscopy. Robotic assistance can explain the rate of LPNs as it is not accessible in all centers. We could not individualize robotic and classical laparoscopy in our data as the code was the same in 2018. This robotic subset was identified only after 2019. Bic et al. showed a slight difference in favor of the robot, but it was not statistically significant [26]. Moreover, recent recommendations favoring kidney preservation at all costs have led to more complex tumors being operated on robotically rather than laparoscopically, potentially increasing complication rates and introducing a recruitment bias that shifts the statistics in favor of laparoscopy.

The declarative nature of the PMSI database may lead to an underestimation of the number of complications. However, its use primarily for billing purposes could also lead to over-reporting. Refund rules are standard for all hospitals, so we have assumed these biases do not affect the type of surgery being compared. The large sample size limits the risk of these biases significantly impacting the overall results. It is also important to note that the PMSI database does not include outpatient care, underestimating complications that do not require hospitalization.

Given the limited or no information on epidemiologic characteristics of the different patient groups, such as comorbidity and tumor parameters, we conducted a statistical analysis of the relative risk to confirm or refute the results. Also, data on the conversion rate of partial to radical nephrectomy were unavailable because they were already considered radical nephrectomy in the national health insurance database. Clavien-Dindo classification is probably less precise as we don't have information about surgical revision and may be overestimated.

Despite these clarifications, our method was retrospective and declarative, based on the hospital's information

about the complications encountered by each patient to obtain reimbursement for the care provided. Fair reporting is therefore encouraged in entering data into the database. Other medical specialties have already published studies showing that the data from the PMSI-MCO are reliable with an excellent predictive value [27–29], which offers a great overall picture of various complication rates.

A closer examination of high- and low-volume centers would be helpful to determine a center effect. However, adjusting for tumor complexity and patient comorbidities would be necessary, as low-volume centers operate on the most uncomplicated cases. Unfortunately, this type of detail is not yet available.

PMSI data provide valuable information on the complications associated with different surgical approaches, whether laparoscopic or open. For low-volume centers, these results provide an overview of the risks and benefits associated with each method, which can be better anticipated and managed. Clinicians can also evaluate treatment options based on their experience and the tools available in their facility, better inform patients, and improve shared decision-making in line with patient preferences.

Conclusions

Exploitation of the French national health insurance data showed a decrease in length of stay and postoperative laparoscopic partial and radical kidney surgery complications for urinary infection, acute renal failure, bowel occlusion, sepsis, and postoperative anemia.

Abbreviations

ICD-10	International classification disease, 10th edition
PMSI-MCO	Programme de médicalisation des systèmes d'information – Médecine chirurgie obstétrique.
LRN	Laparoscopic radical nephrectomy
OPN	Open partial nephrectomy
LPN	Laparoscopic partial nephrectomy
KDIGO	Kidney disease improving global outcomes
RR	Relative risk
eGFR	Estimated Glomerular fonction rate

Acknowledgements

We thank Mr. Bruno Sarfati from REAL CONSULTING DATA, 11-19 rue de la Vanne SOPARQ Batiment C, 92 120 Montrouge France, for collecting data from PMSI-MCO database.

Author contributions

Protocol/project development: P.E., G.P., C.M. Data collection: G.P. Data analysis: J.S. Manuscript writing: G.P., B.B., J.H., C.M. Critical revision of the manuscript: B.B., P.E., J.S., J.H.

Funding

None.

Data availability

Data were collected retrospectively from ATIH (Agence technique de l'information sur l'hospitalisation) with the aknowledgements of Mr Bruno Sarfati from REAL CONSULTING DATA https://www.atih.sante.fr/https://www.scansante.fr/.

Declarations

Ethics approval and consent to participate

This Study has been evaluated and approved by the Ethics Committee of Nancy CHRU Hospital, represented by Mr Yves Martinet, and this research has been carried out in accordance to current French and European ethical standards, as well as The Code of Ethics of the World Medical Association. Furthermore, the Ethics Committee of Nancy CHRU Hospital has waived the need for informed consent.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests

Received: 23 January 2024 / Accepted: 7 October 2024
Published online: 21 October 2024

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