Robot-assisted Partial Nephrectomy: Is Routine Urinary Catheterization Still Mandatory in the Era of Enhanced Recovery?

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OBJECTIVE To assess the benefits and safety of noncatheterization during robot-assisted partial nephrectomy within an enhanced recovery protocol.

MATERIALS AND METHODS A single-center retrospective comparative study was carried out of consecutive patients who underwent a robot-assisted partial nephrectomy between February 2015 and December 2017 within an early recovery program. The patients who received a urinary catheter were compared with those who did not in terms of postoperative complications, acute urinary retention rates, urinary tract infection rates, and lengths of hospital stay.

RESULTS Of the 145 patients who followed an early recovery program after robot-assisted partial nephrectomy in the study period, 96 received a urinary catheter and 49 did not. There was no significant difference between these 2 groups in terms of the rates of acute urinary retention (3% vs 6%, respectively; $P = .393$), urinary tract infection (3% vs 2%; $P = .707$), postoperative complications (14% vs 18%; $P = .445$), or readmissions within 30 days (8% vs 6%; $P = .636$). However, patients who did not receive a catheter had shorter initial and total (including readmissions) lengths of hospital stay (respectively 2.16 days vs 2.56 days; $P = .058$, and 2.27 days vs 3.40 days; $P < .001$).

CONCLUSION Our findings challenge the routine use of urinary catheterization during robot-assisted partial nephrectomies. Noncatheterization does not seem to increase the risk of postoperative urinary retention. Only catheterizing specific at-risk patients may prove beneficial. UROLOGY 124: 148–153, 2019. © 2018 Elsevier Inc.

Renal cancer is the 13th most common cancer worldwide with 338,000 new cases each year.[1] Partial nephrectomy is now the recommended treatment in Europe for tumors up to 7 cm in diameter (cT1 tumors).[2]

The past decade has seen the rise of minimally invasive surgery. Indeed, laparoscopy offers oncological outcomes similar to those of open surgery but with lower postoperative morbidity.[3] Compared with a standard laparoscopy, robotic assistance reduces warm ischemia time, length of hospital stay (LOS) and allows difficult-to-access renal tumors to be excised.[4,5] Robot-assisted minimally invasive surgery is now an integral part of early recovery program (ERP) that aim to reduce hospital stays and postoperative morbimortality.[6]

The standard practice during prolonged abdominal surgery is to systematically insert a urethral urinary catheter intraoperatively. This allows diuresis to be quantified during and after surgery but also reduces the risk of postoperative urinary retention.[7] However, some studies report that urinary catheterization increases LOS and the risk of urinary tract infection (UTI).[8] This is why early catheter removal is currently recommended in most ERP.[9]

There are very few studies in the literature on ERP after robot-assisted partial nephrectomy (RAPN).[10,11] To our knowledge, the effects of noncatheterization during the procedure have never been evaluated. The objective of our study was therefore to evaluate the benefits and safety of noncatheterization during RAPN as part of an ERP. The secondary objectives were to assess the effects of noncatheterization on LOS and postoperative complications and to identify risk factors for acute urinary retention

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(AUR) which could be used to distinguish patients for whom catheterization is required.

MATERIALS AND METHODS

This was a single-center retrospective comparative study conducted in a teaching hospital in Lyon, France.

Population

All patients who underwent RAPN within an ERP between February 2015 and December 2017 in the study center were included. Since January 2017 our enhanced recovery protocol has evolved: we decided to stop using urinary catheters during surgery. The cohort was divided into 2 groups, the first composed of patients for whom a urinary catheter was inserted during surgery (the catheterized or control group) and the second composed of those who were not catheterized during surgery (the noncatheterized group). Patients who underwent open surgery and those who refused the ERP were excluded.

The patients' epidemiological, clinical, and surgical data were collected from their medical files. Patients were given an information sheet describing the ERP during their preoperative consultation with the surgeon and the anesthetist.

Patients in the noncatheterized group were asked to urinate spontaneously immediately before surgery and then again at the first postoperative mobilization.

For the patients in the catheterized group, the urinary catheter was inserted under sterile conditions by a qualified surgical nurse in the operating theater. This was then removed in the postanesthesia care unit (day 0) or the following morning (day 1) at 6 AM depending on the end time of the operation.

Surgical Procedure

The RAPN procedure was standardized and carried out by surgeons with 3 different levels of experience (< 20 operations, 20-50 operations, and > 50 operations). An intraoperative ultrasound scan was performed in some cases to better locate endophytic tumors. Similarly, indocyanine green fluorescence angiography was used for some patients to verify the efficacy of the vascular clamping.

The patients were anesthetized using intravenous lidocaine with a 1.5 mg/kg induction dose followed by 1 mg/kg/h intraoperatively. No morphine-based drug was administered during surgery. Volume expansion during the procedure was restricted to 500-1000 mL of lactated Ringer's solution. No mannitol or furosemide was administered during surgery. The patients' heart rate, arterial blood pressure, and pCO_2 were monitored but no specific blood volume monitoring was used. No surgical drains were used.

Clinical and Tumor Characteristics

Each patient's clinicopathological parameters before, during, and after surgery were recorded, notably details of their preoperative and postoperative renal function and hemoglobin levels. The renal nephrometry score was used to evaluate and classify each tumor.[12] Details of the surgical procedure such as the duration of the operating room (OR) occupation time, war ischemia time, and any intraoperative complications were also noted.

TNM staging was performed using the 2009 classification and the nucleolar stage of clear cell and papillary renal carcinomas was assessed using the International Society of Urological Pathologyclassification.[13]

Outcome Measures

The primary outcome measure was the incidence of AUR in the 2 groups. Postoperative AUR was defined by a full bladder (> 400 mL) measured by BladderScan with an inability to urinate spontaneously or a high postvoid residual urine volume (> 350 mL). Patients with AUR were initially catheterized once to empty the bladder. In patients still unable to urinate after this process, an indwelling catheter was subsequently inserted then removed the following day and alpha blockers were administered to the men.

The secondary outcome measures were the rates of postoperative UTI, the rates and types of postoperative complications, and the LOS in the 2 groups, during the initial hospital stay and in the first 30 days after discharge. Urinary infection was defined as the presence of functional signs of urethral irritation with or without fever, with leukocyturia ($> 10^4$ leukocytes/mL), and bacteriuria ($> 10^4$ uropathogens/mL).[14]

Statistical Analysis

Quantitative variables were expressed as means and categorical variables as percentages. The 2 groups of patients were compared by analysis of variance for quantitative variables and by chi-square tests for categorical variables. All statistical analyses were performed using Statistical Package for the Social Sciences Statistics (v. 19). Statistical significance was defined as $P < .05$.

RESULTS

Patient Characteristics

A total of 145 patients were included in the study and completed the care pathway of the ERP (supplementary table); with 96 patients in the catheterized group and 49 in the noncatheterized group. Three patients refused the protocol. Table 1 lists the clinicopathological characteristics of the patients and of the renal tumors. In the cohort, we noticed 6 (4%) opening of the collecting system and 6 (4%) surgeries without clamping. Eighty-two percent (119/145) of the lesions were malignant with 5% (7/145) of positive margins. Most of the tumors were either clear cell (53.8%) or tubulopapillary (14.5%) carcinomas. The 2 groups were similar in terms of pre- and initial intraoperative variables. Surgery lasted longer on average for patients in the catheterized group (206 minutes vs 172 minutes, $P < .0001$). Mean glomerular filtration rate (using CKD-EPI) was 86.2 mL/min/1.73 m^2 in the preoperative period and 81.3 mL/min/1.73 m^2 1 month after surgery. No patient required dialysis in the first 30 days after initial discharge from the hospital.

Effects of Noncatheterization on Postoperative Outcomes

Acute Urinary Retention. Table 2 compares the postoperative outcomes of the 2 groups. Across the 2 groups, 6 patients in total (4%) developed AUR. In the catheterized group, the catheter was removed on day 0 in the postanesthesia care unit for 35% (n = 33) of the patients and on day 1 for 58% (n = 56) subjects. There was no significant difference between the rates of AUR in the 2 groups

Table 1. Preoperative parameters in patients with and without urinary catheter

	Cohort	C Group	NC Group	*P* Value
Number	145	96	49	
Mean age (y)	56.2	55.7	57.1	.581
Male n (%)	99 (68%)	67 (70%)	32 (65%)	.584
Mean BMI	25.9	25.7	26.2	.526
Mean ASA Score	1.7	1.7	1.8	.150
1 n (%)	54 (37%)	41 (43%)	13 (27%)	
2 n (%)	81 (56%)	48 (50%)	33 (67%)	
3 n (%)	10 (7%)	7 (7%)	3 (6%)	
Anticoagulant/antiplatelet treatment	19 (13%)	14 (15%)	5 (10%)	.448
Prostatic antecedent	25 (25%)	13 (19%)	12 (38%)	.054
Prostatic medical treatment	13 (13%)	6 (9%)	7 (22%)	.077
Surgeon's experience				.769
< 20 cases n (%)	16 (11%)	10 (10%)	6 (12%)	
20-50 cases n (%)	15 (10%)	10 (10%)	5 (10%)	
> 50 cases n (%)	114 (79%)	76 (80%)	38 (78%)	
Mean tumor size (mm)	28.4	28.3	28.6	.884
Mean RENAL score	6.3	6.4	6.2	.445
Mean warm ischemia time (min)	19.3	19.5	19.3	.484
Mean OR occupation time (min)	194.6	206.2	172.6	< .0001

ASA, American Society of Anesthesiologists; BMI, body mass index; C Group, catheterized group; NC Group, noncatheterized group; OR, operating room.

(6%, n = 3 in the noncatheterized group, vs 3%, n = 3 in the catheterized group; *P* = .393). The 3 patients in the noncatheterized group who developed AUR were all older than 50 years and 2 were already being treated for benign prostatic hyperplasia. Two of these patients were able to urinate spontaneously again after their bladder was emptied by catheterization and the remaining patient was catheterized for 24 hours. All 3 were discharged on the second day after surgery. No patient in the noncatheterized group presented with AUR in the first 30 days after discharge vs 2 patients in the catheterized group (0% vs 2%, *P* = .311). The cumulative incidences of AUR between surgery and the control appointment were thus 5% (n = 5) in the catheterized group and 3 (6%) in the noncatheterized group.

Table 2. Effects of noncatheterization on postoperative outcomes

	C Group	NC Group	*P* Value
Number	96	49	
Removal of urinary catheter			
D0	33 (35%)	–	
D1	56 (58%)	–	
D2	7 (7%)	–	
Postoperative AUR n (%)	3 (3%)	3 (6%)	.393
Postoperative UTI n (%)	3 (3%)	1 (2%)	.707
Complications within 30 days after discharge			
AUR n (%)	2 (2%)	0 (0%)	.311
UTI n (%)	5 (5%)	2 (4%)	.765
Early mobilization (mean in days)	0.39	0.24	.102
D0 n (%)	60 (63%)	37 (76%)	
D1 n (%)	35 (36%)	12 (24%)	
D2 n (%)	1 (1%)	0 (0%)	
Gas resumption (mean in days)	1.08	1.02	.139
D1 n (%)	88 (92%)	48 (98%)	
D2 n (%)	8 (8%)	1 (2%)	
LOS (mean in days)	2.56	2.16	.058
Discharge D1 n (%)	2 (2%)	9 (19%)	
D2 n (%)	66 (69%)	34 (69%)	
> D2 n (%)	28 (29%)	6 (12%)	
Readmissions n (%)	8 (8%)	3 (6%)	.636
Duration of readmission (mean in days)	4.38	1.25	.047
Total LOS (including readmissions days)	3.40	2.27	< .0001

AUR, acute urinary retention; D, day; LOS, length of hospital stay; UTI, urinary tract infection.

Urinary Tract Infection. There was no significant difference between the 2 groups in terms of UTI rates, either during the immediate postoperative period (3%, n = 3 in the catheterized group, vs 2%, n = 1, in noncatheterized group; *P* = .707) or in the first 30 days after discharge (5%, n = 5 in the catheterized group vs 4%, n = 2 in the noncatheterized group; *P* = .765). Of the 7 patients who developed UTI after initial discharge from hospital, 2 patients in the catheterized group were febrile and were readmitted. The 5 other patients had low urinary tract infections with positive urinalysis and were treated as outpatients. Over the entire study period, the cumulative incidences of UTI were 8% (n = 8) in the catheterized group and 6% (n = 3) in the noncatheterized group.

Early Mobilization. Seventy-six percent (n = 37) of the patients in the noncatheterized group were mobilized on day 0 vs 63% of those (n = 60) in the catheterized group (*P* = .102). Among these patients, 98% of those in the noncatheterized group were able to have a laxation response on day 1 vs 92% of those in the catheterized group (*P* = .139).

Postoperative Complications. Tables 3 and 4 list the complications developed by the patients, respectively, in the immediate postoperative period and in the first

Table 3. Complications in the immediate postoperative period categorized by Clavien system

	Cohort	C Group	NC Group	*P* Value
Number	145	96	49	
Complications n (%)	23 (16%)	14 (14%)	9 (18%)	.445
Clavien score				
I (n)	14 (9.7%)	8 (8%)	6 (12%)	
AUR	6	3	3	
Macroscopic hematuria	3	3	–	
Desaturation	1	–	1	
Abdominal pain	2	1	1	
Port pain	1	1	–	
Hemoperitoneum	1	–	1	
II (n)	6 (4.1%)	4 (4%)	2 (4%)	
Febrile UTI	4	3	1	
Uvula edema	1	–	1	
Urinary fistula	1	1	–	
IIIa (n)	2 (1.4%)	2 (2%)	–	
Renal artery pseudoaneurysm	2	2	–	
IV (n)	1 (0.8%)	–	1 (2%)	
Respiratory distress	1	–	1	
V (n)	0	–	–	

30 days after discharge from the hospital. There were no cases of deep vein thrombosis. There were no deaths in the first 30 days after initial discharge.

Eleven patients in total (8%) had to be readmitted to hospital in the first 30 days after discharge for 16 complications diagnosed.

Length of Hospital Stay. The mean LOS in our cohort was 2.43 days (1-9 days) with a median stay of 2 days. Of the 11 patients (8% of the cohort) who were discharged on the first day after surgery, 9 belonged to the noncatheterized group. One hundred patients (69%) were discharged on the second day after surgery, including 34 of the patients in the noncatheterized group and 66 of the catheterized group.

The mean initial LOS was shorter in the noncatheterized group (2.16 days vs 2.56 days), with borderline

Table 4. Complications within 30 d after discharge from the hospital

	Cohort	C Group	NC Group	*P* Value
Number	145	96	49	
Unplanned consultation n (%)	28 (19%)	18 (19%)	10 (20%)	.668
General practitioner n	12	7	5	
Emergency room n	16	11	5	
Readmissions n (%)	11 (8%)	8 (8%)	3 (6%)	.636
Complications diagnosed for readmissions n (Clavien Score)	16	13	3	
I	6	5	1	
AUR	2	2	–	
Wall abscess	1	1	–	
Fever	1	1	–	
Retroperitoneal Hematoma	1	–	1	
Renal colic	1	1	–	
II				
Febrile UTI	2	2	–	
IIIa				
Renal artery pseudoaneurysm	4	3	1	
IIIb	4	3	1	
Fistula urinary	3	2	1	
Collecting system's blood clot	1	1	–	
IV	0	–	–	
V	0		–	

significance (P = .058). The mean readmission LOS was significantly lower in the in the noncatheterized group (1.25 days vs 4.38 days, P = .047). The total LOS was significantly lower in the noncatheterized group (2.27 days vs 3.4 days, $P < .001$, Table 2).

DISCUSSION

To our knowledge, this study is the first to evaluate the effects of noncatheterization during RAPN within an ERP. The rate of postoperative AUR in the noncatheterized group was not significantly higher than that in the catheterized group. This result is in keeping with Yoo et al's report of similar rates of AUR for patients decatheterized on day 1 or day 2 after rectal surgery (4.8% vs 4.7%, respectively, P = 1.0).[15]

Five of the 6 patients who developed AUR were men and all 5 were older than 50 years. Two were being treated for benign prostatic hyperplasia and 1 of these 2 had previously had prostate disease. It may seem that systematic intraoperative catheterization is recommended for these patients (age > 50 years and/or with a history of prostate disease or being treated for a prostate condition). However, 78% (n = 77) of the men in our cohort were older than 50 years at diagnosis and only 7% (n = 5) developed AUR. In this cohort therefore, systematic catheterization would have lead 14 men to be unnecessarily catheterized for each case of AUR prevented. Preoperative risk factors for AUR warranting catheterization for the corresponding patients cannot be determined from this study because the number of cases of AUR is too low for a significant multivariate analysis. This is notably because robot-assistance reduced the duration of surgery for our patients (mean OR occupation time was 194 minutes), which decreased the risk of subsequent AUR. We noticed that the mean OR occupation time was significantly longer for the catheterized group. This could be explained by the time spent to insert a urinary catheter, especially when it is often student nurses, in a teaching hospital, who do the procedure. It could lead to cost savings in noncatheterized group.

Many studies have shown that urinary infections are the first cause of hospital-acquired infections, accounting for 40% of these.[16,17] Furthermore, it is well established that the main risk factor for developing UTI in hospitals is indwelling catheterization.[18] There was no significant difference between the rates of UTI in the 2 groups. This is probably also because of the small number of cases involved [n = 4 (3% of the cohort)]. Note nonetheless that in the first 30 days after discharge, 8 patients in the catheterized group (8%) developed UTI vs 3 in the noncatheterized group (6%).

The noncatheterized patients in our study spent less time in hospital than those who were catheterized did. Noncatheterization can reduce LOS by facilitating early mobilization and therefore the resumption of intestinal transit. Early mobilization also reduces the risk of thromboembolism.[19] Henriksen et al[20] report that early and repeated mobilization as part of an enhanced recovery program has positive effects on postoperative recovery and muscle atrophy. Furthermore, noncatheterized patients suffer less psychological stress on awakening, which is in keeping with the demedicalization at the heart of ERP. Likewise, Kehlet and Wilmore[21] identify psychological readiness as a factor that promotes recovery while physical and psychological stress hinder early postoperative recovery. Noncatheterization also avoids the morbidities associated with catheter use, with the incidence of urethral lesions estimated to be 0.3%.[22] None of the catheterized patients in our study showed urethral lesions but the 30-day follow-up period is probably too short for urethral strictures to have appeared.

Our study also shows that RAPN is compatible with ERP. The mean LOS of our patients was 2.43 days, which compares favorably with the 3.6 days reported by Kaouk et al[23] in their study, with similar complication rates (16% vs 14.4%, respectively).

The rate of readmissions to hospital within 30 days in our study (8%, 11 patients) is similar to the one reported elsewhere in the literature. Patel et al[10] report a readmission rate of 5% with their recovery protocol and Brandao et al[24] 4.5%.

Noncatheterization may have a negative impact on patient monitoring during anesthesia. Indeed, urethral catheterization allows hourly diuresis to be quantified during surgery, which can be used to infer the patient's blood volume. According to the French Anesthesia and Critical Care Society however,[25] hourly diuresis is often insufficient to properly monitor hemodynamics and low intraoperative diuresis values do not necessarily indicate renal hypoperfusion. A number of noninvasive methods have recently been developed for cardiac monitoring during surgery, among which, esophageal Doppler ultrasonography. Although this technique is expensive, it is one of most reliable and least invasive blood volume monitoring techniques.[26] According to French Anesthesia and Critical Care Society guidelines for enhanced recovery after elective colorectal surgery,[27] a restrictive strategy is recommended for intraoperative fluid management. Our ERP did not involve any specific monitoring of patient blood volume; to be eligible however, patients had to have a low American Society of Anesthesiology score, 1.7 on average for this cohort.

The limitations of our study include its single-center and retrospective nature. Furthermore, no cost analysis was performed. While the medicoeconomic benefits of ERP have already been demonstrated,[28] we could have highlighted the cost effectiveness of shorter hospital stays and the cost reduction associated with reduced catheter usage and catheter-associated UTI rates.[17] Another limitation was the small number of cases of AUR, which precluded multivariate analysis to identify the corresponding risk factors. This may have allowed a "target" population to be identified that would have benefitted from systematic urethral catheterization. This could be investigated in future studies involving larger cohorts.

CONCLUSION

The present study calls into question the routine use of urinary catheterization during RAPN. Urinary catheters are risk factors for infections, limit postoperative mobilization, and increase LOS. In our study, noncatheterization did not increase the postoperative rate of AUR. This measure is in keeping with the spirit of ERP, whose aim is maximal demedicalization. Catheterization may nonetheless be beneficial for a subset of the population at high risk of developing AUR.

SUPPLEMENTARY MATERIALS

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.urology.2018.09.028.

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