Laparoscopic Nephrectomy in Patients Undergoing Hemodialysis Treatment

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ABSTRACT

Background and Objectives: To report our experience with laparoscopic nephrectomy (LN) in patients undergoing hemodialysis compared with normal counterparts.

Methods: Seventeen patients (20 renal units, Group 1) undergoing hemodialysis underwent LN, which was indicated due to nonfunctioning kidney in 17 and suspected malignancy in 3 renal units. Radical nephrectomy (RN), simple nephrectomy (SN), and simple nephroureterectomy (SNU) were performed in 3, 9, and 8 cases, respectively. For comparison, 101 patients (Group 2) without CRF (chronic renal failure) who had undergone LN were evaluated. In this group, RN, SN, SNU and radical nephroureterectomy (RNU) were performed in 48, 41, 8, and 4 patients, respectively.

Results: The mean age (36.9±13.1 vs. 48.7±19.4yr, P=0.002) and BMI (22.1±4.8 vs. 26.2±5.1kg/m^2, P=0.001) were lower in Group 1, whereas ASA (physical status score of American Society of Anesthesiologists) score (2.8±0.4 vs. 1.5±0.7, P<0.001) was lower in Group 2. The estimated blood loss (111±114 vs. 184±335mL, P=0.34) was higher in Group 2. Both groups were comparable in regard to mean operative time (133±79 vs. 119±45, P=0.70), hematocrit drop (4.69±3.9 vs. 3.86±3.0, P=0.29) and hospital stay (3.6±3.3 vs. 3.3±2.4 days, P=0.34). Meanwhile, when only patients undergoing SN and SNU in the study cohort (n=17 in Group 1 and n=49 in Group 2) are taken into consideration, no significant difference was observed between the 2 groups in terms of any kind of above-mentioned perioperative parameters. No case in Group 1 was converted to open surgery due to metabolic problems.

Conclusions: LN in patients undergoing hemodialysis may be performed safely by an experienced laparoscopy team.

Key Words: Laparoscopy, Nephrectomy, Kidney, Hemodialysis.

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INTRODUCTION

Currently, laparoscopic nephrectomy (LN) has become a standard of care at many urological centers worldwide. Shorter hospital stay, quicker convalescence, and better cosmetic results have made laparoscopic renal surgery the procedure of choice both for the surgeons and the patients.[1,2]

Laparoscopic nephrectomy sometimes has to be performed on dialysis-dependent chronic renal failure (CRF) patients. However, it is well known that these patients are more susceptible to metabolic acidosis during pneumoperitoneum. Moreover, they have a tendency to bleed due to alterations in platelet function and an increased infection rate that place them at a higher risk for any kind of surgery.[3] To our knowledge, a few reports have evaluated the safety of LN in CRF patients under hemodialysis treatment, and only one of them compared the outcomes of LN with outcomes of patients with normal renal function.[4] Accordingly, the aim of the present study was to report our experience with LN in patients undergoing hemodialysis in comparison with their normal counterparts.

MATERIALS AND METHODS

Patients

Between September 2005 and October 2009, 158 patients underwent LN at our institution. Among them, 17 patients (20 renal units, Group 1) were undergoing hemodialysis treatment. For comparison, 138 patients with normal renal function (Group 2) who had undergone LN were evaluated. However, the initial 20 cases of Group 2 were excluded from the analysis due to a steep learning curve of LN with a potentially higher conversion rate to open

surgery [30% (6/20) in the first 20 cases].[5] In addition, 14 partial nephrectomy cases were also excluded, because the operative technique is not identical and is more challenging. For the same reasons, 2 hemi-nephroureterectomies and an ectopic pelvic nephrectomy case were also excluded from the analysis. Consequently, 101 patients with normal renal function undergoing LN during the same periods were included in the study as Group 2.

The prospective data of the patients were recorded on a computer Web application database and retrospectively reviewed for the present study. In Group 1, LN was indicated because of nonfunctioning kidney (17 renal units) and suspected malignancy (3 renal units). In this group, radical nephrectomy (RN), simple nephrectomy (SN), and simple nephroureterectomy (SNU) were performed in 3, 9, and 8 cases, respectively. In Group 2, RN (n=48), SN (n=41), SNU (n=8), and radical nephroureterectomy (RNU) (n=4) were performed. Demographic data and indications for surgery are presented in **Table 1**. Four of the procedures in Group 1 were carried out using the transperitoneal (2 RN and 2 SN) approach, while 16 of the cases were performed via the retroperitoneal technique (1 RN, 7 SN, and 8 SNU). During the study period, all LNs in both groups were performed unilaterally.

Preoperative Evaluation

Before surgery, all patients underwent routine preoperative laboratory investigations, including total blood count, kidney function tests, and coagulation tests [such as, prothrombin time, partial thromboplastin time, and international normalized ratio (INR)]. Meanwhile, they were preoperatively classified based on American Society of Anesthesiologists (ASA) scale as ASA Grades 1, 2, 3, and 4, denoting healthy patients, cases with mild, severe, and life-threatening systemic diseases, respectively. To improve impaired platelet function, all patients continued regular dialysis sessions, 3 times a week, and LN was performed on the day after dialysis.[6] Meanwhile, preoperative preparation of the patients also included early withdrawal of drugs, such as acetylsalicylic acid or anticoagulant drugs that affect platelet function.

Table 1.
Demographic Data of the Study Cohort

	Chronic Renal Failure Patients	Non-Chronic Renal Failure Patients	P Value
Number of Patients/Renal Units	17/20	101/101	
Sex (female/male)	7/10	42/59	
Mean Age, Years (range)	36.9 ±13.1(14–7)	48.7 ±19.4 (1–82)	0.002
Body Mass Index (range)	22.1 ±4.8(13.7–30.1)	26.2 ±5.1 (13.3–44.4)	0.001
ASA score	2.8 ±0.4	1.5 ±0.7	<0.001
Operation			
Radical Nephrectomy	3	48	
Simple Nephrectomy	9	41	
Simple Nephroureterectomy	8	8	
Radical Nephroureterectomy	—	4	
Operative technique			
Transperitoneal	4	42	
Retroperitoneal	16	63	
Indications			
Renal mass	3	48	
VUR	8	8	
Hypertension	5	5	
Recurrent urinary tract infection	3	34	
Stone	—	6	

Preoperatively, all patients underwent radiologic examinations, such as kidney-ureter-bladder plain film, voiding cystouretrography [for vesicoureteral reflux (VUR)], urinary ultrasonography, and abdominopelvic computerized tomography where indicated. All operations were performed or mentored by a single attending surgeon (OS). Both groups were compared regarding demographic data, including age, body mass index (BMI), and operative factors like operative time and blood loss with the aid of a structured form adopted from University of Michigan Laparoscopy Database Chart Abstraction form.

Surgical Technique

Both techniques were performed as described in published reports.[7,8] In summary, after induction of general anesthesia, the patient was placed in the preferred semiflank and lateral positions for transperitoneal and retroperitoneal approaches, respectively. For both techniques, the ureter was identified, transected, and ligated with clips, and its proximal part was followed to the renal hilum. For patients with VUR, the ureter was transected at the level of bifurcation of the iliac vessels where the cuff on the bladder was left intact. It is worth mentioning that mainly monopolar and bipolar instruments were used for coagulation in the study cohort.

Postoperative Investigations

After surgery, patients mentioned in the present report were evaluated for factors, such as change in hematocrit values, estimated blood loss, length of hospital stay (LOS), and any postoperative clinical manifestations. Meanwhile, blood gas analysis for the evaluation of arterial pH values was done just before induction of the anesthesia and after transferring the patient to the recovery room. In addition, complication data were graded according to the modified Clavien Classification System that encompasses 30 days after surgery.[9] Dialysis was reinstituted for CRF patients on postoperative day 1 with accompanying careful heparinization.

Statistical Analysis

For comparison of parameters in both groups, statistical analysis using the Mann-Whitney U test, Student *t* test, and chi-square test were carried out as appropriate. The statistical significance was defined as a $P<0.05$.

RESULTS

Both the mean age [36.9±13.1 (14 to 67) vs. 48.7±19.4 (1 to 82) years, P=0.002] and the mean BMI [22.1±4.8kg/m^2 (13.7 to 30.1) vs. 26.2±5.1kg/m^2 (13.3 to 44.4), P=0.001] of patients in Group 1 were lower relative to Group 2. The mean ASA score (2.8±0.4 vs. 1.5±0.7, P<0.001) was significantly lower in Group 2.

The mean maximal diameter [10.52±4.25cm (range, 3 to 20) vs. 7.73±2.77cm (range, 4 to 14.5), P=0.007] and weight [317.59±223.55g (range,12 to 970) vs. 103.44±122.37g (range, 38 to 510), P<0.001) of the surgical specimens resected in Group 2 were significantly higher. Meanwhile, the mean maximal tumor diameter in patients with renal mass was also significantly higher in Group 2 [1.67±1.04cm (range, 0.5 to 2.5) in Group 1 and 5.65±2.28cm (range, 2.4 to 15) in Group 2].

However, when only patients undergoing SN and simple SNU in the study cohort (n=17 in Group 1 and n=49 in Group 2) were taken into consideration for analysis, no significant difference was observed between groups in terms of mean maximal diameter [7.42±2.46cm (range, 4.0 to 12.0) vs. 8.33±3.66cm (range, 3.0 to 17.0), P=0.505] and weight [98.23±132.69g (range, 38 to 510) vs. 142.80±137.61g (range, 12 to 530), P=0.302) of the surgical specimen.

None of the patients in Group 1 was converted to open surgery due to anesthesiological reasons, whereas 1 patient in Group 2 was converted to open surgery, because of intolerable CO_2 retention. When preoperative and postoperative arterial pH values in CRF patients were compared, no statistically significant difference was observed (7.35±0.07 vs. 7.33±0.06, P=0.84).

The estimated blood loss was 111±114mL (range, 15 to 500) in Group 1 and 184±335mL (range, 0 to 2500) (P=0.34) in Group 2. Both groups were comparable in regard to mean operation time [133±79min (range, 45 to 412) in Group 1 vs. 119±45min (range, 30 to 344) in Group 2; P=0.70). The mean hematocrit drop was found to be 4.69±3.9 (range, 1 to 7) in Group 1 vs. 3.86±3.0 (range, 2.6 to 10) in Group 2 (P=0.29) before institution of any blood transfusion. In addition, the mean LOS was 3.6±3.3 days (range, 1 to 17) and 3.3±2.4 days (range,1 to 17) (P=0.34) for Groups 1 and 2, respectively. Meanwhile, no statistically significant difference was observed between patients undergoing SN+SNU in both groups in terms of blood loss, operative time, hematocrit drop, and LOS **(Table 2)**.

None of the patients in Group 1 was converted to open surgery due to surgical considerations, whereas 5 patients in Group 2 (4 RN, 1 SN) were converted to open surgery, because of procedural complications [renal venous bleed-

Table 2.
Operative Data of the Patients Undergoimg Simple Nephrectomy and Simple Nephroureterectomy

	Chronic Renal Failure Patients (n=17)	Non-Chronic Renal Failure Patients (n=49)	P Value
Blood loss in mL (range)	81±61 (15–250)	93.7±102.5 (0–500)	0.886
Operative time in minutes (range)	119±48 (45–210)	113±38 (40–200)	0.638
Hematocrit drop (range)	4.2±4.1 (−5.1–10.8)	4.0±3.3 (−2.6–10)	0.751
Hospital stay in days (range)	2.7±0.8 (1–4)	3.0±1.5 (1–8)	0.988

Table 3.
Complications Encountered During Laparoscopic Procedures

Clavien Classification	Complication	Group 1 n (%)	Group 2 n (%)
Grade I	Elevation of body temperature	—	13 (13.13%)
Grade II	Incision site infection	2 (10%)	1 (1.01%)
	Blood transfusion	1(5%)	5 (5.05%)
	Incisional hernia	—	1 (1.01%)
	Urinary tract infection	—	4 (4.04%)
Grade IIIa	Urinary leakage requiring catheterization	—	—
Grade IIIb	Closure of dehiscent noninfected wound in the OR under general anesthesia	—	1 (1.01%)
	Renal venous bleeding	—	1 (1.01%)
Grade IVa	Vena cava injury	—	–
Grade IVb	Colonic injury	—	1 (1.01%)
Total		3 (15%)	27 (27.3%)

ing (RN), intolerable CO_2 retention (1 RN- mentioned above), aberrant venous bleeding from parasitic veins [(1 RN) and severe adhesions to the surrounding tissues (1 SN)]. Twenty-seven (27.3%) complications [grade I (n=13), grade II (n= 11), grade IIIb (n=2), and grade IVb (n=1)] were encountered in Group 2, whereas 3 (15%) complications (all grade II) were noted in Group 1 (P=0.401, **Table 3**). Similarly, no significant difference was discerned when SN+SNUs in both groups were compared in terms of complications (P=0.298, **Table 4**).

DISCUSSION

Uremic patients diagnosed with reflux nephropathy, chronic pyelonephritis or renal calculi leading to recurrent urinary tract infection, uncontrolled hypertension, renal tumors, or complicated polycystic kidneys are candidates for LN.[10,11] The conventional open approach is generally associated with significant morbidity in these patients due to prolonged recumbence and impaired healing. Thus, the laparoscopic approach is a rational option to avoid these problems[9]; however, many conditions concerning mainly the anesthesia procedures do affect the laparoscopic success of uremic patients. It is important to emphasize that CRF is associated with metabolic acidosis that can be aggravated with carbon dioxide (CO_2) insufflation during laparoscopic surgery. Briefly, insufflation with carbon dioxide may affect respiratory capacity, especially when an underlying predisposing condition exists. Furthermore, pneumoperitoneum reduces lung capacity and pulmonary compliance.[12] Hypercapnia consequently may deteriorate the underlying chronic metabolic acidosis of the uremic patients leading to cardiovascular collapse and fatal dysrhythmias.[13] Despite these increased risks of anesthesia, the present study revealed that LN is not associated with increased operative and postoperative morbidity in terms of metabolic acidosis in the hands of an

Table 4.
Complications of Patients Undergoimg Simple Nephrectomy and Simple Nephroureterectomy

Clavien Classification	Complications	Group 1 (n= 17)	Group 2 (n= 49)
Grade I	Elevation of body temperature	—	7 (14.3%)
Grade II	Incision site infection	1 (5.9%)	1 (2.0%)
	Blood transfusion	1 (5.9%)	1 (2.0%)
	Incisional hernia	—	1 (2.0%)
	Urinary tract infection	—	—
Grade IIIa	Urinary leakage requiring catheterization	—	—
Grade IIIb	Closure of dehiscent noninfected wound in the OR under general anesthesia		
	Renal venous bleeding		—
Grade IVa	Vena cava injury	—	—
Grade IVb	Colonic injury	—	1 (2.0%)
Total		2 (11.8%)	11 (26.4%)

experienced anesthesiology team. Because none of the patients in this report were converted to open surgery due to anesthesiological problems, pre- and postoperative pH values were not significantly different. Similarly, Demian et al[14] reported that carbon dioxide absorption did not significantly decrease the serum pH of uremic patients, which returned to its preoperative value at the end of the procedure.

Laparoscopic surgical techniques were developed to reduce the morbidity of the surgical management. Due to the clear advantages of laparoscopic surgery, the indications of this approach have expanded dramatically over the years.[15] Currently, large series of LN have higher (86% to 97%) success rates with lower rates of conversion to open surgery (3% to 14%), major (3% to 4%), and minor complications (15% to 24%).[7,16] These results are generally similar to the perioperative outcomes we obtained in both groups. Also, it is interesting that there was no conversion to open surgery in Group 1, whereas, 4 radical and 1 simple nephrectomies were converted to open surgery in Group 2. This can be attributed to the fact that LN for dialysis patients had been initiated 2 years after the introduction of the laparoscopy program at our institution and completion of its steep learning curve. On the other hand, the complication rate is the major factor for determining the standard of care. Overall complication rates in Groups 1 and 2 estimated according to the Clavien grading system in the present study were not significantly different (15% vs. 27.3%). In the largest study, performed by Shoma et al[11] in patients with CRF, the conversion rate to open surgery was reported as 6% (4/64), whereas major and minor complication rates were detected as 6% and 9.2%, respectively. The authors experienced complications like pneumothorax, large hematoma, colonic perforation, and life-threatening bleeding. The authors mentioned that their overall complication rate of 15.2% reflected their learning curve in which the transperitoneal approach was used at first, followed by retroperitoneoscopy after gaining some experience. In a study with a similar methodology to ours, Fornara et al[4] compared 19 patients undergoing hemodialysis treatment with 20 consecutive patients with normal renal function. The authors noted 4 (21%) minor complications, such as fever and thrombotic occlusion of arteriovenous fistula, in the dialysis group, and 2 complications [pulmonary infection (n=1) and urinary tract infection (n=1)] in the nondialysis group. Lastly, in the study by Goel et al,[17] which compared the outcomes of the laparoscopic vs. the open approach in patients with CRF, the authors reported similar rates of major [7.5% (3/40) vs. 10% (4/40)] and lower rates of minor [5% (2/40) vs. 35% (14/40)] complications in the laparoscopy group. Consequently, according to the present evidence, it is rational to consider LN as a standard of care in patients undergoing hemodialysis treatment with similar complication rates in comparison with patients with normal renal function.

During laparoscopic surgery, bleeding mainly results from injuries to the intraabdominal vessels or organs, from insertion of the Veress needle or trocars, or during operative dissection. Meanwhile, the tendency to bleed,

mainly due to platelet dysfunction, increases the risk of bleeding with laparoscopy in CRF patients.[18] In this study, neither of the cases in Group 1 was converted to open surgery due to bleeding and no late hemorrhage was observed. Moreover, the mean estimated blood loss in Group 1 (111mL) was similar to that reported by Fornara et al[4] (180mL) and Shoma et al[11] (77 mL). These data contrast with the current knowledge of the increased bleeding tendency of CRF patients. This finding may be explained first by the awareness of the bleeding tendency in CRF patients by the laparoscopy team. The team could have high degree of suspicion regarding the risk of bleeding in these patients, which led them to perform laparoscopic surgery more meticulously. Secondly, all patients underwent heparin-free dialysis a day before surgery, which is helpful in reducing the risk of bleeding.[17] Thus, it seems that chronic coagulation problems inherent to uremia are not a major problem in LN.

The present study has some limitations that merit mentioning. First, this study comprises different operations, such as SN, RN, and NU mentioned under the title of LN. Although this methodological approach may complicate the comparison of perioperative data for both groups, we believe that perioperative outcomes of these operations are not much different from each other except for the large tumors treated with RN. Since the mean pathological tumor diameter is 5cm in the present report, both groups are quite comparable in terms of perioperative outcomes. Nevertheless, it is worth mentioning that the reason for insignificant but notable blood loss in Group 2 might be attributed to the significant number of patients who underwent RN in Group 2 (3 vs. 48 patients). To overcome this major limitation, we also compared the outcomes of patients with SN+SNU in both groups and detected no significant difference in any of the mentioned perioperative parameters and the rate of complications **(Table 2 and Table 4)**. On the other hand, it should also be stressed that laparoscopic and open nephrectomies were not compared in patients undergoing hemodialysis. This comparison might also be helpful to determine the value of the laparoscopic approach in patients undergoing hemodialysis.

CONCLUSIONS

It is clear that many issues associated with end-stage renal disease affect the ability to perform LN.[19] The present study revealed that LN in patients undergoing hemodialysis might be performed safely under the expertise of an experienced laparoscopy team, considering comparable perioperative outcomes obtained in patients without CRF. Accordingly, LN should be considered as the procedure of choice for patients undergoing hemodialysis with the advantage of low morbidity.

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