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NECESSITY OF URETERAL CATHETER DURING LAPAROSCOPIC PARTIAL NEPHRECTOMY

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ABSTRACT

Purpose: Laparoscopic partial nephrectomy (LPN) is a relatively recently introduced method of treating renal tumors and, as such, surgical technique is evolving. In open series urinary fistula formation represents a common postoperative complication. In the laparoscopic approach investigators have advocated the placement of a ureteral catheter with retrograde dye injection to visualize caliceal entry to aid in closure. In this study we assessed the necessity of ureteral catheter placement during LPN in decreasing urinary leakage.

Materials and Methods: From February 1998 until November 2002 laparoscopic partial nephrectomy was performed in 103 patients with renal tumors. The patients were assessed retrospectively and divided into 2 groups according to placement (group 1) or no placement (group 2) of an external ureteral catheter. Group 1 included 54 patients (mean age ± SD 57.4 ± 13.4 years) and group 2 included 49 patients (mean age ± SD 57.5 ± 10.9). Intraoperative and postoperative parameters including blood loss, operative time, ischemia time, mass size, complications and hospital stay were reviewed and compared between the 2 groups.

Results: There were no differences between the 2 groups in mean estimated blood loss (group 1, 394.7 cc vs group 2, 291.5 cc, $p = 0.07$), postoperative serum creatinine (group 1, 0.95 mg/dl vs group 2, 0.89 mg/dl, $p = 0.12$), requirement for pain medication (group 1, 8.9 mg vs group 2, 4.9 mg morphine equivalents, $p = 0.12$), hospital stay (group 1, 3.1 vs group 2, 2.9, $p = 0.29$) and warm ischemia time (group 1, 28 minutes vs group 2, 26.5 minutes, $p = 0.18$). Mean total operative time was significantly longer for group 1 compared to group 2 (191.1 vs 149.4 minutes, respectively, $p = 0.001$). Postoperative urinary leakage requiring prolonged drainage occurred in 1 patient in group 1 and 1 in group 2. In both cases caliceal entry was identified and sutured.

Conclusions: With experience caliceal entry can be identified without the need for a ureteral catheter in patients undergoing LPN for a tumor less than 4.5 cm. Urinary fistula may occur despite caliceal entry and repair. A ureteral catheter may not decrease urinary fistula in patients undergoing LPN.

Key Words: laparoscopy, nephrectomy, catheterization, stents

Laparoscopic partial nephrectomy (LPN) is evolving as an acceptable method for treating renal tumors.[1] Most initial reports have included select patients with unifocal, small and exophytic lesions located away from the collecting system.[2,3] As experience with this technique has increased, larger and deep lesions in proximity to the collecting system are being approached via laparoscopy.[4] In open series urinary leakage and fistula formation are recognized postoperative complications with an incidence of up to 17%.[5] To obviate this risk and to visualize an opened renal calix for closure, the use of ureteral catheter and retrograde injection of diluted dye has been advocated. We assessed the usefulness of ureteral catheter placement in preventing urinary leakage during LPN.

MATERIALS AND METHODS

The data from 103 laparoscopic partial nephrectomies from February 1998 to November 2002 were reviewed (table 1). The database containing this information had been granted an exemption from the hospital Institutional Review Board. All the patients had a single, localized, unilateral, sporadic tumor less than 4.5 cm in diameter and normal contralateral kidney. All patients underwent a standardized approach as outlined.

The patients were retrospectively divided in 2 groups according to placement (group 1) or no placement (group 2) of a ureteral catheter at the initiation of the procedure. These groups were sequential in that group 1 included the initial 54 patients with a stent who were approached and group 2 was comprised of the subsequent 49 patients without a stent. Patients with preoperative serum creatinine higher than 1.5 mg/dl or tumor size larger than 4.5 cm were excluded from study. Intraoperative and postoperative parameters including blood loss, operative time, ischemia time, mass size, complications and hospital stay were retrospectively reviewed and compared between the 2 groups. Statistical analysis was performed using the unpaired Student t test.

Our technique of LPN has been previously reported.[6] Briefly, for catheterization a 5Fr open-ended ureteral catheter was cystoscopically inserted over a guide wire into the renal pelvis before surgery. A syringe was filled with diluted methylene blue attached to the ureteral catheter in preparation for retrograde injection. A 3-port transperitoneal approach was mainly used. The renal hilum was meticulously mobilized to dissect the renal artery and vein individually. A laparoscopic flexible ultrasound probe was used to visualize the tumor and to determine the proposed line of parenchymal

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TABLE 1. *Demographic data*

	Group 1	Group 2	p Value
No. men (%)	33 (61.1)	26 (53.1)	
Mean age ± SD (range)	57.4 ± 13.4 (32–82)	57.5 ± 10.9 (34–79)	0.49
Mean body mass index ± SD (range)	28.3 ± 5.5 (19.8–46.7)	27.4 ± 3.5 (20.9–33.3)	0.28
Mean American Society of Anesthesiology score ± SD (range)	2.2 ± 0.5 (1–4)	2.4 ± 0.5 (2–4)	0.16
Mean cm mass ± SD (range)	2.3 ± 0.9 (1.0–4.0)	2.4 ± 0.9 (1.0–4.5)	0.23
Mean mg/dl preop serum creatinine ± SD (range)	0.95 ± 0.24 (0.4–1.4)	0.89 ± 0.23 (0.4–1.5)	0.12

incision. The line was then circumferentially scored with electrocautery, maintaining an approximate 0.5 cm margin around the tumor. The perirenal fat was left in contact with the tumor which was also used as handle. The renal artery and vein were temporally occluded separately with detachable laparoscopic bulldog clamps. Laparoscopic endoshears were used in cold cutting of the renal parenchyma. If achievement of an adequate margin required entry into the caliceal system, it was divided sharply using endoshears and repaired.

In cases in which the ureteral catheter had been preoperatively placed, retrograde injection of diluted methylene blue was performed to locate entry and evaluate pelvicaliceal integrity. If leakage of blue dye was identified, 2-zero polyglactin on an SH needle was used to perform meticulous running suture repair of the collecting system in a watertight fashion. In patients who did not have stents, the magnification offered by the laparoscope was used to identify the collecting system.

Renal parenchymal repair was performed with 2-zero polyglactin parenchymal capsular stitches on a computerized tomography needle. These bites were wide but not deep into the parenchyma. These parenchymal sutures were cinched down over bolsters of polyglactin mesh to achieve hemostasis. The bulldog clamps were released to revascularize the kidney. The excised tumor was extracted intact within the impermeable sac through a 2 to 3 cm extension of a lower abdominal port site incision. A drain was placed at the conclusion and was removed on postoperative day 2 providing drain output was less than 50 cc per 24 hours or output was a creatinine consistent with serum. Followup was comprised of physical examination, serum creatinine, chest x-ray and computerized tomography at 6 months.

RESULTS

Laparoscopic partial nephrectomy was technically successful in all 103 cases without conversion to open surgery. All the procedures were performed using a transperitoneal approach. The right kidney was affected in 29 cases (54%) in group 1 and in 28 (57%) cases in group 2. No significant differences were observed in terms of mean age (group 1, 57.4 years vs group 2, 57.5 years, p = 0.49), American Society of Anesthesiology classification (group 1, 2.2 vs group 2, 2.4, p = 0.16), body mass index (group 1, 28.3 vs group 2, 27.4, p = 0.28) or mean preoperative serum creatinine (group 1, 0.95 mg/dl vs group 2, 0.89 mg/dl, p = 0.12, table 1). There was no difference in mean mass size (group 1, 2.3 cm vs group 2, 2.4 cm, p = 0.23).

A comparison of intraoperative and postoperative data is depicted in table 2. There were no differences between the 2 groups in terms of mean estimated blood loss (group 1, 394.7 cc vs group 2, 291.5 cc, p = 0.07), mean postoperative serum creatinine (group 1, 1.01 mg/dl vs group 2, 0.94 mg/dl, p = 0.15), requirement for pain medication (group 1, 8.9 mg vs group 2, 4.9 mg morphine equivalents, p = 0.12) and mean hospital stay (group 1, 3.1 days vs group 2, 2.9 days, p = 0.29). Mean warm ischemia time was also comparable for both groups with 28 vs 26.5 minutes for groups 1 and 2, respectively (p = 0.18). Mean total operative time was significantly longer for group 1 compared to group 2 (191.1 vs 149.4 minutes, respectively, p = 0.001).

A total of 5 (4.8%) intraoperative complications occurred, 3 in group 1 (1 case of bleeding requiring transfusion, 1 case of duodenal tear and 1 renal lower pole artery avulsion) and 2 in group 2 (2 cases of bleeding requiring transfusion). Postoperative complications occurred in a total of 6 (5.8%) patients, 3 in group 1 (atelectasis in 1, hematuria requiring bladder catheterization in 1 and urine leak in 1) and 3 in group 2 (atelectasis in 1, ureteropelvic junction obstruction in 1 and urine leak in 1), respectively. The case of ureteropelvic junction obstruction occurred in an 81-year-old patient in whom flank pain developed after being discharged home. This condition was managed conservatively with placement of an indwelling ureteral stent.

Urinary leakage was detected by high drain output greater than 50 cc per 24 hours (with high creatinine level) in 1 patient in group 1 (3.8 cm, lower pole oncocytoma) and 1 patient in group 2 (2 cm, lower pole renal cancer). Each patient had undergone laparoscopic caliceal suture repair of the collecting system. Both patients were treated successfully with suction drains until removal on postoperative days 11 and 13, respectively. No patients had radiographic evidence of urinary leakage on postoperative cross-sectional imaging at routine followup visits.

DISCUSSION

The management of renal tumors has undergone a dramatic evolution during the last few years.[1] Laparoscopic partial nephrectomy is a recently introduced minimally invasive method of treating renal tumors. Most initial reports have included only highly selected patients with unifocal, small and exophytic lesions away from the collecting system.[2,3] With increasing experience, larger and deeply infiltrated lesions have been approached via laparoscopy, necessitating sharp entry into the pelvicaliceal system to ensure adequate margins of tumor resection.[4] LPN may be technically challenging and the complications of this approach are still being evaluated. The most common complication in open partial nephrectomy series is urinary leakage with a mean incidence of 6.5% (range 2.1% to 17%).[5,7]

Campbell et al reported 45 cases (17%) of urinary fistula formation in a series of 259 partial nephrectomies.[5] Centrally located tumor, tumor size greater than 4 cm, the need for

TABLE 2. *Intraoperative and postoperative data*

	Group 1	Group 2	p Value
Mean total operative mins ± SD (range)	191.1 ± 56.1 (108–330)	149.4 ± 43.9 (67–255)	0.001
Mean warm ischemia mins ± SD (range)	28.0 ± 7.1 (13–42)	26.5 ± 8.5 (12–55)	0.18
Mean cc estimated blood loss ± SD (range)	394.7 ± 390.7 (50–1,500)	291.5 ± 212.4 (50–1,900)	0.07
Mean mg morphine equivalent ± SD (range)	8.9 ± 16.6 (02–76)	4.9 ± 5.1 (0.2–16.9)	0.12
Mean mg/dl postop serum creatinine ± SD (range)	1.01 ± 0.34 (1.5–1.9)	0.94 ± 0.27 (0.4–1.6)	0.15
Mean days hospital stay ± SD (range)	3.1 (1–11)	2.9 (1–18)	0.29

major reconstruction of the collecting system and extracorporeal surgery were all correlated with an increased risk of urinary fistula formation. Moreover, the authors reported a relatively stable incidence of the urinary fistula formation despite the decrease in the use of the ureteral stent. In contrast a study by Polascik et al showed a decrease in fistula formation in patients who underwent ureteral stent placement.[8] However, in that study the mean tumor size in patients with urinary fistula was 10 cm and comparison with this series of small tumors is not applicable.

Our current protocol establishes the diagnosis of perioperative urinary leakage if excessive drainage fluid is noted that also demonstrates an increased creatinine on postoperative day 2. We found urinary leakage in 1 patient in group 1 (catheter) and 1 in group 2 (no catheter), supporting the idea that ureteral catheter and retrograde injection of a dye is not always helpful in preventing urinary leakage. In both cases the tumor was exophytic, less than 4 cm and localized at the lower pole of the kidney. In a series of 50 LPNs Gill et al reported 1 case of postoperative urinoma.[9] The procedure was performed without using a ureteral catheter for a 1.5 cm almost completely exophytic renal tumor, which suggests that tumor diameter is not always related to urinary leakage. As a consequence the authors suggest that, although no obvious entry into the collecting system occurred, caliceal integrity cannot be definitively confirmed during surgery.

To prevent urinary fistula several measures have been used including closing renal parenchymal defect or covering it with adjacent fat, fascia or oxidized cellulose.[10] Urinary leakage may occur after any type of partial nephrectomy because of delayed necrosis of the coagulated or sutured cut surface.[11] In a multicenter review on 51 LPNs postoperative urinary leakage was observed in 3 patients (6%). Two were treated with an indwelling Double-J stent (Medical Engineering Corp., New York, New York) for 7 and 14 days and 1 required open conversion. The authors suggested that central coagulation necrosis with electrocautery was responsible for fistula formation which could be attributed to the combination of UltraCision scalpel (Ethicon Endo-Surgery, Cincinnati, Ohio) and bipolar coagulation used for the renal resection.[11]

In our current practice monopolar electrocautery is used only to trace the margin of resection circumferentially around the tumor on the surface of kidney. The tumor is then elevated from the tumor bed by placing countertraction with the suction cannula, which also simultaneously aspirates the blood, thereby maintaining a clear operative field. A laparoscopic scissor is than used to perform cold cutting of the renal parenchyma, avoiding any risk of delayed tissue necrosis and urine leak. The magnification afforded by the laparoscope combined with the bloodless field ensures an adequate line of parenchymal resection, and prompts recognition of the pelvicaliceal system. If entry into the pelvicaliceal system occurs, the targeted calix or renal pelvis may be divided sharply and sutured under clear visualization. With this technique ureteral catheter use did not elicit a decreased urinary fistula formation in this series. Additionally, no delayed urinomas were observed in our series at a mean radiographic followup of 19.8 months (range 7 to 53).

Alternative techniques for renal collecting system closure after LPN have been proposed but with uncertain results. In a multi-institutional experience in 53 patients who underwent LPN, the resection bed was sealed by either fibrin impregnated hemostatic gauze or heat activated tissue adhesive. In this series postoperative urinoma formation requiring reintervention was reported in 5 cases (10%).[12] Also in experimental animal model, Banks et al reported urinary fistula in 2 of 6 pigs that underwent LPN with closure of the pelvicaliceal system with fibrin glue.[13]

Our study does have some limitations. The study is a retrospective nonrandomized single institution review. Another weakness is the inevitable fact that we do not ultimately know the percentage of patients in group 2 who had caliceal entry. Since no catheter was used to identify caliceal entry points we cannot comment on the exact incidence of entry. Even with the superb visualization offered by laparoscopy, caliceal entry may be missed, especially if the collecting system is entered in more than 1 location. Interestingly, the 2 patients in whom leakage developed were identified intraoperatively to have caliceal entry which was sutured in both cases. Another limitation of our results is the relatively small tumor size. It is unknown if stent placement is helpful in patients with large tumors undergoing LPN. Despite these limitations ureteral catheterization may not be necessary, since visual cues can be used to identify most caliceal entry points. In this series the use of the ureteral catheter did not decrease the incidence of urinary fistula but was associated with longer procedure times.

CONCLUSIONS

Ureteral catheter placement to identify caliceal entry may not be necessary among experienced laparoscopists performing laparoscopic partial nephrectomy on tumors less than 4.5 cm. Laparoscopic magnification and visualization may be used to identify caliceal entry, which may be suture repaired, thus obviating the need for retrograde stent injection for leak identification. Nevertheless, *fistula may occur* even if caliceal entry is identified and sutured, and retroperitoneal drainage may be necessary to avoid complications from urine leak.

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