A Prospective Study of Laparoscopic Radical Nephrectomy for T1 Tumors—Is Transperitoneal, Retroperitoneal or Hand Assisted the Best Approach?

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Purpose: We designed a prospective, randomized clinical trial to compare 3 common approaches to laparoscopic radical nephrectomy, namely transperitoneal, retroperitoneal and hand assisted.

Materials and Methods: A total of 33 patients with a solid renal mass of 7 cm or less were prospectively enrolled in alternating fashion to a hand assisted procedure, a transperitoneal procedure with morcellation and a retroperitoneal procedure with intact specimen extraction. A single surgeon performed all operations. Preoperative, intraoperative and postoperative criteria were compared among the 3 techniques.

Results: A total of 11 patients underwent each type of procedure. There was no significant difference in age, American Society of Anesthesiologists class, body mass index or tumor size among the groups. Mean operative time was significantly lower using the hand assisted approach, whereas estimated blood loss was similar in all 3 groups. Incision size, hospital stay and time to normal daily activity were less using the transperitoneal approach. While not significant, there was a trend toward less narcotic use in the transperitoneal group. Hernia formation was seen with increased frequency in the hand assisted group.

Conclusions: In our series the hand assisted approach had significantly shorter operative time than the transperitoneal or retroperitoneal approach but it had the greatest risk of hernia formation. The transperitoneal approach was associated with a significantly shorter hospital stay and the earliest resumption of normal activity.

Key Words: kidney, laparoscopy, nephrectomy, outcome assessment (health care)

In the past radical nephrectomy necessitated a large flank incision associated with substantial pain and morbidity. The laparoscopic approach to radical nephrectomy was first reported in 1991 by Clayman et al.1 To date laparoscopic radical nephrectomy has been shown to result in cancer control and survival benefits comparable to those of its open counterpart.2 At the same time it offers significant benefits in terms of patient recovery and morbidity.3 Several techniques are used for this operation and less is known about the relative advantages and disadvantages of each approach. In addition to pure laparoscopic methods, the HA technique has become a popular approach to minimally invasive surgery in academic and community settings.4

In the current study we performed a prospective, randomized comparison of TP, RP and HA approaches to laparoscopic radical nephrectomy in patients with clinical stage T1 solid renal masses. We compared these procedures in terms of mean operative time, incision size, hospital stay, estimated blood loss, narcotic use, time to oral intake, convalescence and complications as well as time to return to driving, work and normal daily activity.

MATERIALS AND METHODS

From February 2001 through February 2005 we examined 33 consecutive laparoscopic radical nephrectomies performed at our institution by a single surgeon (RBN). All 33 cases were clinical stage T1 solid renal masses. Patients were assigned in alternating fashion to the HA, TP or RP approach. For example, case 1 in February 2001 was done in HA fashion, case 2 was done in RP fashion, case 3 was done in TP fashion, case 4 was done in HA fashion and so on.

For the HA approach we used a GelPort® with 2 additional 12 mm ports. The hand port site was closed with running loop zero polyglyconate sutures. The TP approach was done using 3, 12 mm ports and the periumbilical incision was subsequently enlarged to 2.5 cm for morcellation with ring forceps in a LapSac®, which was deployed using a method that we have previously described using an Endo-Catch™ device as an introducer and frame.5 In TP cases closure was performed with interrupted zero polyglactin sutures. In RP cases we used 3 ports, namely an AutoSu-

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Study received Northwestern University Institutional Review Board approval.
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ture™ blunt tip trocar 10 mm balloon port and 2, 12 mm ports. The retroperitoneal space was developed with an AutoSuture™ Extra View sterile dilating balloon. For specimen extraction in the RP approach 2 port sites were connected and the intact specimen was entrapped in a 15 mm Endo-Catch™ bag (AutoSuture™ Ecatch15).

Preoperative parameters were recorded in all subjects, including age, ASA class and BMI. Intraoperative data were documented, including operative time measured from the time of incision to the final closing stitch, incision size in cm and estimated blood loss in ml. Estimated blood loss was determined from operating room records based on the suction canister. Lap pads were not used during HA surgery due to concern over inadvertently leaving them inside the patient. Tumor histopathology and kidney weight were determined from pathology reports. Because our method of morcellation generates fragments approximately 2 to 4 cm in diameter, unlike an electrical morcellator, it was possible to evaluate histology and margin status in TP cases. We also recorded time to oral intake, hospital stay, narcotic use in intravenous morphine equivalents and any complications.

All patients undergoing laparoscopic radical nephrectomy have standing orders for advancing the diet as tolerated and for discharge home after they are able to tolerate oral intake and ambulate. Patients completed a questionnaire at the 2-week, 1-month and 3-month followup visits that asked questions about complications, driving, return to work and ability to perform at a normal activity level. At these and any additional subsequent followup visits patients also underwent a full physical examination. The study protocol was approved by the Northwestern University Institutional Review Board.

Statistical analysis was performed using SPSS (SPSS, Chicago, Illinois). Comparisons between groups were made with an intent to treat analysis using ANOVA.

RESULTS

The table lists clinical characteristics in the 3 patient groups. Mean age in the study was 60.3 years (range 42 to 86), which was not significantly different among the groups (p = 0.53). ASA class and BMI were also similar in the 3 groups. A total of 21 patients had a history of abdominal surgery, of whom 6 were randomized to HA, 7 were randomized to TP and 8 were randomized to RP.

There was no significant difference among the 3 approaches with respect to estimated blood loss or narcotic use (see table). Incision size was significantly smaller in the TP group than in the HA or RP group, although specimens were morcellated. Specimen weight was similar in the 3 groups (p = 0.30). Mean operative time was 139 minutes in the HA group, which was significantly less than in the TP or RP group (196 and 185 minutes, respectively, p = 0.01). Average hospital stay was significantly less in the TP group than in the HA or RP group (2.1 days, p = 0.05).

In the HA group pathological study revealed clear cell carcinoma in 8 patients, papillary carcinoma in 2 and a complex cyst in 1. In the TP group there were also 8 cases of clear cell carcinoma along with sarcomatous disease, oncocytoma and a benign complex cystic mass in 1 each. In the RP group pathological study revealed clear cell carcinoma in 7 patients and oncocytoma in 4. The adrenal was spared in all except 2 TP and 2 RP cases. Margins were negative in all patients. Followup computerized tomography performed at a median of 20 months of followup showed no evidence of disease. To date none of the patients in this study has experienced port site seeding, local or distant recurrence, or cancer specific death.

There were several complications in our study, including 1 conversion from a TP to an HA procedure. Postoperatively 1 patient each in the HA and TP groups was rehospitalized for drainage of pleural effusions and 1 in the RP group had pancreatitis and esophagitis, which prolonged initial hospitalization. Other complications were incisional hernia in 4 HA cases, flank bulge in 2 RP cases and flank pain or paresthesia in 5 RP cases.

At the 2-week followup visit 7 of 8 patients (85.7%) in the TP group had already resumed driving compared to 4 of 10 (40%) in the HA and 1 of 10 (10%) in the RP group. By this time 6 of 11 patients (54.5%) in the TP group had returned to work/full activity compared to 2 of 9 (22%) in the HA and 0 of 9 (0%) in the RP group. The majority of patients in all groups complained only of minor incisional pain and they used narcotic pain medications for less than 1 week postoperatively. The use of nonnarcotic pain medications was widely variable in the groups and it was primarily related to ongoing comorbidities, such as arthritis.

DISCUSSION

Since the initial laparoscopic nephrectomy was performed in 1990 for a renal tumor,1 this alternative to open radical surgery has become increasingly popular.2,3 There are several ways to perform laparoscopic radical nephrectomy, including the standard transperitoneal approach, and the HA TP and RP approaches. Groups at various institutions favor 1 particular approach, while others tend to select the approach based on patient characteristics. Nonetheless, there
are no good data to evaluate whether 1 of the 3 approaches is superior to the others in terms of outcomes. There have been a few retrospective studies comparing techniques of laparoscopic nephrectomy but to our knowledge this is the first prospective, sequentially randomized study to evaluate all 3 techniques head to head.

In 2001 we retrospectively compared the initial 12 HA and 12 RP laparoscopic nephrectomies performed at our institution. This study was not randomized, nor did we include TP in the analysis. However, as in the current study, we found no significant difference in estimated blood loss, time to oral intake or narcotic use between the HA and RP groups.

In 2002 Nelson and Wolf compared 22 HA laparoscopic radical nephrectomy with 16 TP procedures with morcellation. This study was not randomized and subjects were selected for HA based on various factors, including obesity and large tumors on preoperative computerized tomography. As in the current study, the investigators found similar estimated blood loss, narcotic use and time to oral intake for the 2 methods. Mean hospital stay was 2.7 days for HA surgery and 2.4 days for TP surgery in their study, a trend that did not attain statistical significance (p = 0.62). Like us, they found significantly lower operative time in HA procedures, although in their study this difference became smaller with time as they became more efficient with the standard TP approach. They performed simple logistic regression analysis, which suggested that the most important factors determining operative time in laparoscopic nephrectomy are procedure type, surgeon experience and adrenal sparing.

In our initial experience we reported a mean operative time of 238 and 255 minutes for HA and RP procedures compared to 139 and 185 minutes, respectively, in this later series. The difference in operative time between the HA and RP methods is now large enough to achieve statistical significance. The current study was not initiated directly following our earlier report and by the time of this study the surgeon had performed at least 50 radical nephrectomies using each method. Thus, even with considerable experience with the RP approach the HA method maintained its superiority in terms of operative speed when cases were randomized. When considering the controversy over the cost-effectiveness of laparoscopic vs open nephrectomy, a decrease in operative time is a central component for controlling the overall cost of the procedure. Furthermore, this may be useful in patients with significant comorbidities to limit the duration of surgery and anesthesia.

While the HA approach had shorter operative times in our study, we found that the TP approach had a significantly shorter hospital stay than the HA and RP approaches (2.1 vs 3.4 and 3.6 days, respectively). While it was not statistically significant, there were trends toward less time to oral intake and narcotic use in the TP group (p = 0.19 and 0.30, respectively). Although a shorter operative time lowers cost in the HA approach, the lower overall hospital stay and postoperative morbidity of the TP approach offer a considerable advantage over HA and RP.

There are several possible explanations for these results. As expected, morcellation allowed smaller incision size in the TP vs the HA and RP groups (2.9 vs 7.3 and 6.3 cm, respectively). All kidneys in this series were entrapped and morcellated using a LapSac® attached to an EndoCatch™ II device with manual fragmentation using a ring forceps under direct vision, as previously described. As described by Urban et al, the LapSac® has been shown to be effective for renal morcellation. We prefer to enlarge the periumbilical port from 12 mm to approximately 2.5 cm to facilitate extraction of larger pieces of renal tissue. This not only aids in more rapid specimen extraction, but also we believe that it may enable better pathological analysis of the specimen. Indeed, Gettman et al found that narcotic requirements, hospital stay and time to normal activity were similar for the TP approach with intact specimen extraction vs morcellation. Thus, we believe not only that smaller incision size in the TP approach is responsible for less morbidity, but also the location of the incision in the midline may account for less pain, paresthesia and abdominal bulges from muscular atrophy related to nerve injury. In addition, 4 patients in the HA group had extraction site hernia, of which 2 have already required operative correction. We believe that the high rate of hernia formation is related to decreased fascial strength at the umbilicus, which is exploited by hand port extraction. In the general surgery literature it is well documented that incisional hernias are most likely to occur with incisions involving the umbilicus.

The greater amount of intestinal manipulation in the HA approach may explain the delayed day of hospital discharge and trends toward longer time to oral intake and more prolonged overall recovery compared with those in the TP group. Because the RP approach involves the least bowel manipulation, theoretically this should promote earlier return of bowel function, hospital discharge and resumption of normal activity. We did not find this to be the case. Instead, we found that there is some morbidity associated with the flank extraction excision site in our series. Desai et al recently performed a randomized comparison of TP and RP radical nephrectomy with intact specimen extraction and found a similar time to oral intake, ambulation and complete convalescence for the 2 approaches. In our study compared with the TP morcellation group significantly fewer patients in the RP group were able to return to driving and work/full activity by the 2-week followup visit (p = 0.02 and 0.001, respectively). There was also a trend toward greater narcotic use and 2 cases of flank bulge. Furthermore, patients in the RP group were the only ones to report subjective discomfort months to years postoperatively, including 5 reports of flank pain or paresthesia. This may be related to the more proximal disruption of the somatic and cutaneous nerves innervating the abdominal musculature and skin. Due to its location at the far reaches of the somatic nerve pathways a midline morcellation extraction incision may result in fewer episodes of pain and paresthesia.

One patient in our series required conversion from the TP to the HA approach. This was a difficult dissection and, while such a conversion is considered a complication of the pure laparoscopic transperitoneal approach, it nevertheless highlights how the HA approach still affords an opportunity to complete such difficult cases laparoscopically.

There are other factors that may be considered when deciding on a particular laparoscopic approach. For example, the RP approach theoretically should be a useful technique in patients with a history of intra-abdominal surgeries and trends toward longer time to oral intake and more prolonged overall recovery compared with those in the TP group. Because the RP approach involves the least bowel manipulation, theoretically this should promote earlier return of bowel function, hospital discharge and resumption of normal activity. We did not find this to be the case. Instead, we found that there is some morbidity associated with the flank extraction excision site in our series. Desai et al recently performed a randomized comparison of TP and RP radical nephrectomy with intact specimen extraction and found a similar time to oral intake, ambulation and complete convalescence for the 2 approaches. In our study compared with the TP morcellation group significantly fewer patients in the RP group were able to return to driving and work/full activity by the 2-week followup visit (p = 0.02 and 0.001, respectively). There was also a trend toward greater narcotic use and 2 cases of flank bulge. Furthermore, patients in the RP group were the only ones to report subjective discomfort months to years postoperatively, including 5 reports of flank pain or paresthesia. This may be related to the more proximal disruption of the somatic and cutaneous nerves innervating the abdominal musculature and skin. Due to its location at the far reaches of the somatic nerve pathways a midline morcellation extraction incision may result in fewer episodes of pain and paresthesia.

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There are other factors that may be considered when deciding on a particular laparoscopic approach. For example, the RP approach theoretically should be a useful technique in patients with a history of intra-abdominal surgeries and it also allows early access to the renal hilum. The TP approach offers a larger working space than the RP or HA method as well as a smaller external incision with better
cosmosis than the HA approach and less associated pain/paresthesia than the RP approach. In addition, to our knowledge we are the first to report a significantly shorter hospital stay as well as a more rapid return to normal daily activity for the TP approach than for either of their other approaches. Such factors may have a larger role in overall patient satisfaction with the procedure, particularly in those without a surgical history or in those with few comorbidities suggesting another approach. Decreased hospitalization and earlier return to work/normal activity represent considerable cost savings at the societal level.

Several limitations of our study deserve mention. Specimens were morcellated in the TP group, which had a role in the significantly smaller incision size. Although there are case reports of port site metastasis with morcellation for renal cell carcinoma, the risk does not appear to be increased compared with that seen in other urological laparoscopic procedures or open radical nephrectomy.

Furthermore, strict adherence to measures such as precise draping, and changing gowns and gloves is critical. Accordingly none of the patients in our series have yet experienced any local or distant recurrences, port site seeding or cancer specific mortality at an average of almost 2 years of followup (range 0 to 51 months). Still, because the study began in 2001, followup is relatively short and it is unclear whether differences in cancer control will later emerge among the 3 groups.

Another limitation is that we only included tumors that were 7 cm or less (clinical stage T1) in the current series. Variables such as estimated blood loss and incision size would likely be affected by the inclusion of tumors greater than 7 cm. Larger tumors have been associated with more parasitic vessels, difficult specimen removal and an increased risk of adjacent organ involvement.

In addition, some patients did not respond to all questions on the followup surveys. Even in participants with complete followup data available several outcome measures in this study are subjective in nature. Patients determined when they felt capable of driving or returning to work and the threshold for such decisions may vary among individuals. Furthermore, other parameters, such as when to advance the diet and hospital discharge criteria, can vary among physicians and institutions.

Finally, all nephrectomies in the current study were performed at a teaching hospital by a urologist specializing in laparoscopy or residents under his guidance. There is a learning curve for each of these techniques, as is apparent when comparing the current series with our initial experience. It is unknown whether our findings apply to general urologists worldwide.

CONCLUSIONS

Laparoscopic radical nephrectomy can be done in multiple ways, including via TP, RP and HA approaches. In this randomized, prospective study there were no significant differences in blood loss, time to oral intake or narcotic use among the groups. While all 3 methods appear to provide a substantial decrease in short-term morbidity compared with standard open radical nephrectomy, the TP approach with morcellation had a significantly shorter hospital stay, smaller incision size and earlier return to normal activity. Although the HA technique provided the shortest operative time, short-term and long-term morbidity was greater with this approach. However, the final decision is based on which laparoscopic approach can be tailored to individual patient comorbidities and life-style as well as on surgeon preference, experience and clinical judgment.

**Abbreviation and Acronyms**

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<tr>
<td>ASA</td>
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<td>BMI</td>
<td>body mass index</td>
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<td>HA</td>
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<td>retroperitoneal</td>
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**REFERENCES**

These authors present a prospective, randomized study of 3 laparoscopic approaches to radical nephrectomy for T1 tumors. Although they are not able to definitively determine the best approach for everyone, they certainly elucidate some important points. Hand assisted nephrectomy is associated with an increased risk of incisional hernia. The retroperitoneal approach can result in prolonged discomfort, presumably related to paresthesias. In their cohort hospital stay was significantly less in the transperitoneal morcellated group (2.1 vs 3.4 or 3.6 days).

While these findings can be helpful for counseling patients, previous studies have not demonstrated significant differences when comparing transperitoneal vs retroperitoneal nephrectomy (reference 13 in article) or morcellation vs intact specimen extraction (reference 11 in article). Furthermore, although the authors report pathological margin status without complications related to morcellation, the risks of tumor spillage almost certainly outweigh the minimal benefits. However, similar to open surgery, it is beneficial for surgeons to have familiarity with multiple approaches to best suit the individual patient.

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