MAJOR COMPLICATIONS IN 213 LAPAROSCOPIC NEPHRECTOMY CASES: THE INDIANAPOLIS EXPERIENCE

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ABSTRACT

Purpose: We assessed the incidence of and analyzed factors that may help prevent major complications and open conversion during laparoscopic nephrectomy at our institutions.

Materials and Methods: We retrospectively analyzed all laparoscopic nephrectomies performed between August 1, 1999 and July 31, 2001. Data were stratified for nephrectomy type, intraoperative and postoperative complications. Conversion to open surgery was stratified for emergency versus elective procedures.

Results: Of the 292 laparoscopic procedures performed at our institutions in 2 years 213 (73%) involved laparoscopic nephrectomy, including 84 live donor nephrectomies, 61 radical nephrectomies, 55 simple nephrectomies and 13 nephroureterectomies. A total of 16 major complications (7.5%) occurred, including access related, intraoperative and postoperative complications in 3, 9 and 4 cases, respectively. The conversion rate was 6.1% (13 patients), the transfusion rate was 1.9% and the mortality rate was 0.5% (1 death). Only 1 complication was related to simple laparoscopic nephrectomy, although this group showed the highest rate of elective conversion (7 of 8 elective conversions). Laparoscopic live donor nephrectomy showed the highest rate for emergency conversion (3 of 5 emergency conversions).

Conclusions: Our results reinforce the importance of thorough preoperative imaging, careful patient selection, surgeon experience and skill maintenance in laparoscopy as well as a low threshold for conversion to open surgery. This series provides additional evidence to support the evolution of laparoscopic nephrectomy into a standard of care.

KEY WORDS: kidney, nephrectomy, laparoscopy, intraoperative complications, postoperative complications

Since the initial description of laparoscopic nephrectomy by Clayman et al.,¹ use of the laparoscopic approach for treating benign and malignant disease of the upper urinary tract has been steadily increasing. Nephrectomy has become the most common laparoscopic urological procedure, achieving results similar to open nephrectomy.²–⁴ Despite growing acceptance of laparoscopy in the urological community and obvious patient benefits one must not forget that the potential for severe complications is ever present. Repeat self-critique for improved patient outcome is our ongoing responsibility. We reviewed and analyzed the major complications and conversions to open surgery in our experience with laparoscopic nephrectomy and make recommendations for the prevention, recognition and management of complications.

MATERIALS AND METHODS

Between August 1, 1999 and July 31, 2001, 292 laparoscopic urological procedures were performed at our institutions, of which 213 (73%) involved laparoscopic nephrectomy. The approach was transperitoneal in the majority of the cases, except for 17 simple nephrectomies that were performed via the retroperitoneal approach. Initial access and pneumoperitoneum creation were achieved using an Optiview trocar (Ethicon Endo-Surgery, Cincinnati, Ohio) for the transperitoneal and retroperitoneal approaches, as previously described in the literature.¹ For the transperitoneal approach the patient was positioned in the modified lateral decubitus position and 4 to 5 ports were placed. For laparoscopic live donor nephrectomy the first 43 cases were done using an EndoCatch retrieval bag (Auto Suture, Norwalk, Connecticut) for specimen retrieval and the last 41 were done using a novel manual retrieval technique without a pneumoperitoneum maintaining device through a modified Pfannenstiel incision.² For laparoscopic radical nephrectomy and nephroureterectomy specimens were retrieved intact using an EndoCatch bag and for laparoscopic simple nephrectomy they were retrieved intact or after morcellation. For the retroperitoneal approach we used the technique previously described by Gill.⁷

We retrospectively reviewed the charts of the 213 patient to analyze complications and conversion to open surgery. Patients were grouped into 4 categories according to the procedures performed, including live donor nephrectomy in 84, radical nephrectomy in 61, nephroureterectomy in 13 and simple nephrectomy in 55. All laparoscopic procedures were performed by the same surgeon (A. L. S.). A team of 2 laparoscopic co-surgeons performed 56 live donor nephrectomies. Most procedures were done in a teaching environment with the fellow or resident assisted by the primary surgeon until the level of difficulty exceeded the technical ability of the trainee. At that point the primary surgeon took over.

RESULTS

Overall major complications developed in 16 (7.5%) and open conversion was necessary in 13 (6.1%) of the 213 laparoscopic nephrectomies (table 1). The transfusion rate was...
1.9% and the mortality rate was 0.5% (1 death). Complications were access related in 3 patients, intraoperative in 11 and postoperative in 2 (table 2). Open conversion was subdivided into emergency (5) and elective (8) cases (table 3).

**TABLE 2. Complication type**

<table>
<thead>
<tr>
<th>Type</th>
<th>No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Access related:</td>
<td>3</td>
</tr>
<tr>
<td>Liver injury</td>
<td>2</td>
</tr>
<tr>
<td>Abdominal wall hematoma</td>
<td>1</td>
</tr>
<tr>
<td>Intraop.:</td>
<td>11</td>
</tr>
<tr>
<td>Vascular injury</td>
<td>2</td>
</tr>
<tr>
<td>Bowel injury</td>
<td>2</td>
</tr>
<tr>
<td>Splenic injury</td>
<td>1</td>
</tr>
<tr>
<td>Failed entrapment</td>
<td>1</td>
</tr>
<tr>
<td>Postop.</td>
<td>1</td>
</tr>
<tr>
<td>Respiratory</td>
<td>1</td>
</tr>
<tr>
<td>Gastrointestinal bleeding</td>
<td>1</td>
</tr>
</tbody>
</table>

Complete stapling but allowing the stapler blade to cut the renal vein, causing bleeding from the proximal vein stump. At that time the right hand of the assistant was holding the kidney through a modified Pfannenstiel incision. We have used this method for manual specimen retrieval in the last 41 live donor nephrectomy cases after pure laparoscopic donor nephrectomy. The kidney was immediately removed and hemorrhage was controlled by manual compression until conversion was performed.

Another intraoperative complication was related to bleeding from a renal artery stump after incomplete stapling. The stapler was fired across the renal vein, the kidney was manually retrieved and the assistant hand was reinserted. Pneumoperitoneum was reestablished, allowing manual pinching of the bleeding point until laparoscopic control was achieved by placing a large clip on the renal artery stump.

Two other complications were related to the use of the EndoCatch bag for specimen retrieval. A 57-year-old female donor required splenectomy on postoperative day 1 after a 2 cm. laceration to the spleen occurred during retraction with the EndoCatch device at pedicle stapling. Intraoperatively the laceration was detected and cauterized. The area was then observed for 5 minutes after intra-abdominal pressure was decreased to 4 mm. Hg. The patient became hypotensive later that night. Exploratory laparotomy revealed a large intra-abdominal hematoma and active bleeding from the spleen. Splenectomy was performed without further incident. In another donor during EndoCatch bag specimen retrieval
through a Pfannenstiel incision the kidney slipped off the edge of the bag when it was cinched down and remained within the peritoneal cavity. To minimize the warm ischemia period the Pfannenstiel incision was immediately enlarged to 7.5 cm., allowing the surgeon to insert a hand into the peritoneal cavity. Under laparoscopic assistance the kidney was then manually grasped and removed. An important finding during this complication was that pneumoperitoneum can be preserved when the surgeon arm is placed through an appropriate size incision. It enables adequate laparoscopic visualization during vascular stapling and manual specimen retrieval, which we currently use in all live donor nephrectomies.8

Two complications developed postoperatively. A 45-year-old male had respiratory distress in the immediate postoperative period, requiring reintubation. In addition, a 25-year-old male donor presented with hematemesis on postoperative day 5. He was on ketorolac for pain management. Upper endoscopy was performed and an inflamed duodenal ulcer was diagnosed. The patient was treated with an H2 blocker and required no further intervention.

Laparoscopic radical nephrectomy in 61 patients. In this group 16 and 45 patients underwent laparoscopic radical nephrectomy with and without concomitant adrenalectomy, respectively. There were 5 complications (8%), of which 1 caused death, and 2 emergency conversions to open nephrectomy. Mean tumor size in the kidneys with complications was 4.5 cm. (range 2 to 8). Hemorrhage was the reason for the 2 emergency open conversions in this group. In an 80-year-old woman with an 8 cm. left upper pole tumor the superior mesenteric artery was accidentally divided with the harmonic scalpel when this structure was mistaken for a calcified lymph node. There was no bleeding from either stump. However, suspicion was raised that the superior mesenteric artery may have been involved since the lateral stump of this structure was pulsating, while the medial stump was flaccid. The renal artery was dissected and a large clip was placed at the origin of the artery from the aorta. The heavily calcified renal artery was crushed under the clip and brisk arterial bleeding was noted. The patient underwent emergency exploration through a midline incision. Bleeding was controlled and radical nephrectomy was completed. At that point superior mesenteric artery division was verified. End-to-end anastomosis of the superior mesenteric artery failed due to extensive distal atherosclerosis and a vascular tube graft was placed. This patient received 4 units of blood. Unfortunately at planned second look surgical exploration 24 hours later small bowel ischemia was noted and partial small bowel resection was performed. Subsequently the clinical course slowly deteriorated in the intensive care unit. Major small bowel resection with resultant short gut syndrome was discussed with the family. It was elected not to proceed with further surgery and the patient died. This case represents the single death in our series.

In a 30-year-old female an aberrant right lower pole artery was not identified during pedicle exposure. As a result, the artery was inadvertently incised as dissection proceeded toward the lower pole. The procedure was converted and hemorrhage was controlled. The remaining major complication in this group occurred in a 71-year-old woman who underwent uneventful left radical laparoscopic nephrectomy. On postoperative day 3 melena developed. After normal gastroscopy colonoscopy revealed a semi-circumferential ischemic lesion at the splenic flexure of the colon. No intervention was required. The patient underwent observation and was discharged home without sequelae on postoperative day 8.

Access creation and port placement accounted for 2 complications in this group. A 1.2 cm. liver laceration was caused by the blunt tip of an Optiview device during initial port insertion for right laparoscopic radical nephrectomy. After increasing intra-abdominal pressure to 20 mm. Hg hemostasis was achieved using bipolar electrocautery and packing the laceration with oxidized cellulose. This patient received no blood transfusion and was discharged home on postoperative day 5. An 84-year-old man had a large abdominal wall and scrotal hematoma postoperatively, likely due to limited injury to an inferior epigastric vessel during placement of a 5 mm. port. He underwent observation and remained hemodynamically stable, requiring no blood transfusion. The patient was discharged home on postoperative day 6 and hemotoma resolved.

Laparoscopic nephroureterectomy in 13 patients. In the laparoscopic nephroureterectomy group bladder cuff resection was done in all cases and there were 2 major complications (15%). In a 67-year-old male an accessory small lower pole right renal artery was initially not identified when the renal pedicle was dissected. During dissection of the lower pole this artery was unexpectedly divided, leading to 800 cc blood loss until the stump of the artery was grasped and laparoscopically controlled with clips. The other complication involved a 70-year-old male who underwent uneventful nephroureterectomy but then presented with persistent lower abdominal pain with no associated fever on postoperative day 4. Abdominal computerized tomography (CT) revealed a 3 cm. left pelvic abscess. During open exploration diverticulitis disease involving the sigmoid colon was diagnosed with a small perforation in a diverticulum surrounded by a confined abscess. A small segment of sigmoid colon was resected and end colostomy with a Hartmann pouch was performed. Three months later reoperation was done to re-establish intestinal continuity.

Laparoscopic simple nephrectomy in 55 patients. Laparoscopic simple nephrectomy were performed via the transperitoneal approach in 38 cases and via the retroperitoneal approach in 17. A single surgical complication (2%) occurred in this group as a result of initial transperitoneal 12 mm. Optiview trocar placement into a large Riedel’s lobe that shifted medially while the patient was in the lateral decubitus position for right nephrectomy. Laparoscopic inspection of the peritoneum showed a 12 mm. liver laceration. The whole kidney and hilum were covered by the anomalous liver, precluding performing the procedure via the transperitoneal approach. The 12 mm. initial trocar incision was enlarged to 5 cm. Bleeding from the laceration was controlled with bipolar electrocautery and oxidized cellulose. The patient was then rotated further medial and the procedure was completed via the retroperitoneal approach. The patient was discharged home on postoperative day 5.

Conversion to open surgery in 13 patients. The open conversion rate overall was 6.1%, including 5 emergency and 8 elective procedures (table 3). The 5 emergency conversions occurred as a result of uncontrollable hemorrhage, namely 3 in the live donor nephrectomy group (3.6%) and 2 in the laparoscopic radical nephrectomy group (3.3%). Elective conversion was due to lack of progression in 7 laparoscopic simple nephrectomies and 1 laparoscopic radical nephrectomy.

Discussion

Experience with laparoscopic nephrectomy has increased steadily since the first was performed in 1991 by Clayman et al.1 Laparoscopic nephrectomy for various indications is currently the most common urological laparoscopic procedure. At our institutions it comprised 213 of the 292 laparoscopic urological procedures (75%) performed in the last 2 years.

As more urologists embark on laparoscopic surgery, important lessons can be learned from complications observed by those with extensive experience with the laparoscopic approach. Gill et al reviewed the complication rate associated with laparoscopic nephrectomy in a recent multi-institutional study.8 Of 185 patients 16% had complications and 5% required open conversion. Chan et al reviewed the complication rates of laparoscopic donor nephrectomy at their institution and noted a...
4% major complication rate and a 1.7% rate of conversion. Keoley and Tolley reported a 3% and 5% major complication and conversion rate, respectively, during their first 100 laparoscopic nephrectomies. In our series there were 16 major complications in 213 procedures (7.5%) as well as 13 open conversions (6%). Overall our complication and conversion rates were similar to those previously published. The experience gained in our series was translated to refinements in technique and a set of guiding principles that we believe allows us to decrease the likelihood of future complications during laparoscopic nephrectomy. Realistic preoperative patient education during informed consent regarding the complication and conversion rates is key for decreasing the anxiety related to these occurrences in patients, relatives and the surgeon. It is clear that preoperative imaging tests such as CT must be examined carefully for evidence of aberrant renal vessels, which are present in 25% to 40% of kidneys. However, only CT angiography, magnetic resonance angiography and formal angiography are sensitive enough to rule out renal vascular variants. During laparoscopic nephrectomy when these types of imaging are not available, it would be prudent that after a centrally located renal artery is clipped and incised the surgeon would proceed with careful dissection of the medial aspect of the upper and lower poles of the kidney to avoid any uncontrolled aberrant vessel division. Also, preoperative noncontrast CT showing calcification of the renal artery should be a definite indication to avoid clipping of the artery at the level of calcification. Rather the surgeon should plan to dissect a noncalcified segment and divide the vessel at this level. It is now our practice to examine carefully preoperative noncontrast CT for calcified renal vessels, especially in patients with a history of atherosclerotic heart disease or peripheral vascular disease and in those 70 years old or older. In addition, large hilar tumors distorting the renal hilum on preoperative imaging should receive special attention. In these cases especially on the left side dissection of the suspected renal artery should be extended toward the renal hilum and/or aorta until the renal artery is positively identified.

Bleeding from a torn renal vein branch may have been prevented by more delicate retraction during pedicle dissection. Also, sparing more perihilar fat covering the renal artery and vein branches may be helpful for protecting these vessels from accidental tearing. Metal clip dislodgment from a small venous branch can be prevented by dissection down to the actual vein wall. The more tissue left around a vein before clipping, the higher the chance for clip dislodgment. Leaving about 2 mm of vein distal to the clip and an approximately 3 mm stump between the main renal vein and the first clip may help to avoid dislodgment and allow easy placement of another clip if one dislodges. Applying 2 metal clips or using a snap-on type Hem-o-lock ML clip (Weck Closure Systems, Research Triangle Park, North Carolina) may help avoid this complication.

The most precarious step during live donor nephrectomy is vessel division and kidney retrieval. For safe stapling during left live donor nephrectomy the renal vein should be dissected proximal until enough length is achieved to place the stapler on the medial side of the adrenal vein stump. Renal artery dissection should be confined to the origin of the renal artery off of the aorta and continued into the hilum for about 15 mm. The surgeon must ensure that any proximal or distal clips used for dividing the adrenal, gonadal and lumbar veins would not interfere with stapler placement. If a clip is likely to be within the staple line, it should be replaced by an EndoLoop (Ethicon Endo-Surgery), which does not hinder stapler function. To avoid these problems we recently adopted the technique described by Schuster and Wolf, in which the renal vein branches are coagulated and welded using bipolar cautery before division. Stapler placement is then only dictated by vein length.

Additional complications during the warm ischemia period were associated with using an EndoCatch bag for kidney retrieval. Other's reported bowel injury during live donor nephrectomy related to the metal ring of the EndoCatch bag and multiple complications related to specimen retrieval. Careful handling of the bag during that phase and back table suturing of the bag to the metal ring may probably help avoid these complications.

Trocar related injuries during laparoscopic cases are well-known complications. In our series 2 cases of liver injury occurred during initial access using the Optiview device. Fortunately, neither injury was major secondary to the blunt nature of this device, allowing easy control. Again reviewing preoperative CT more carefully and noting an enlarged liver or a significant Riedel’s lobe that may shift medial when the patient is in the lateral decubitus position may have avoided this complication since we could have chosen an alternative initial port site. In regard to the suspected inferior epigastric artery injury, we are now excluding the rectus muscle from the optional sites for trocar placement. All trocars are placed in the midline or lateral to the rectus muscle. Also, we routinely examine the operative field for hemostasis at 4 mm. Hg at the end of the procedure and remove all trocars under endoscopic guidance since it allows us to identify intraperitoneal or abdominal wall vascular injury.

Although no patients in our series suffered overt bowel injury intraoperatively, 2 complications (0.9%) were attributable to this etiology. The first complication involved a perforated sigmoid colon diverticulitis during laparoscopic nephroureterectomy, while the other was secondary to localized partial bowel ischemia. Bishoff et al reported the incidence of bowel injury during various urological laparoscopic procedures to be similar, ranging from 0.8% to 1.8% of patients. Of these injuries 69% were not recognized intraoperatively and 50% were the direct result of electrocautery use. In all cases in our series the surgeon used an UltraCision harmonic scalpel (Ethicon Endo-Surgery) for dissection. This instrument has been shown to be safe for facilitating dissection during laparoscopic nephrectomy and it is related to decreased lateral tissue damage compared with monopolar electrocautery dissection. We assume that diverticular perforation was a direct result of dissection near the diverticulum thin wall and the incident of partial colonic ischemia may have been secondary to unnoticed small mesenteric vessel injury during medial reflection of the colonic splenic flexure. To prevent inadvertent bowel injury during dissection instruments must be visualized at all times, particular attention must be given to adjacent structures during dissection and the surgeon must remain right on the plane between Gerota’s fascia and the bowel mesentery to minimize the possibility of bowel injury. It is especially true in elderly patients with a history of extensive atherosclerosis and those with a history or imaging suggestive of diverticulitis and/or diverticulosis. Emergency open conversion was done in cases of uncontrollable hemorrhage. The decision to resort to open conversion due to bleeding should be made within seconds because one must bear in mind that the opening process until temporary control of the bleeding is achieved may still require an additional 2 to 5 minutes. Temporarily increasing pneumoperitoneum pressure to 20 mm. Hg, pressure on the bleeding point with a rolled gauze sponge or grasping the stump of a bleeding vessel can provide time for the definitive management of bleeding. Also, placement of a hand assisted device can be considered. Elective conversion was the result of lack of progression and hilar dissection was the obstacle in all cases. Not surprisingly the group with the highest incidence of elective open conversion in our series was undergoing laparoscopic simple nephrectomy. These procedures are often extremely difficult due to extensive scarring, inflammation.
and loss of anatomical planes. In these cases when the plane of dissection has gone astray, we attempt dissection at a different part of the kidney. Each degree of freedom achieved in 1 part of the kidney may improve the ability to dissect a previously difficult area by allowing better exposure or retraction. Changes in patient position, adding another port for retraction or conversion to hand assistance may also be helpful. However, after all possible parts are dissected and no progress is achieved using these maneuvers for 30 minutes it is our policy to convert to open surgery.

Not all patients are candidates for laparoscopy. Even when open surgery is performed, these cases may prove to be a challenge. A history of previous renal trauma, surgery and recurrent infections combined with preoperative imaging revealing massive stranding around the kidney should prompt the surgeon to inform the patient that the conversion rate in his case may be up to 50%. It would decrease patient and family anxiety after conversion has been done and enable the surgeon to use a low threshold for conversion to open surgery. The experience gained in our series was translated to refinements in technique and a set of guiding principles that we believe allows us to decrease the likelihood of future complications during laparoscopic nephrectomy.

CONCLUSIONS

Nephrectomy has become the most common laparoscopic urological procedure. We reviewed the complication and conversion rates in our first 213 laparoscopic nephrectomies. Complications were mainly associated with managing the renal hilum, initial access and specimen retrieval. Uncontrolled hemorrhage was responsible for all emergency open conversions and lack of progression in patients undergoing nephrectomy for benign disease accounted for all elective open conversions. Our complication and conversion rates are similar to those in other reports of laparoscopic surgery and to the incidence in open nephrectomy. Thorough preoperative imaging, careful patient selection, a low threshold for conversion to open surgery, the maintenance of surgeon experience and skill in laparoscopy as well as repeat self-critiquing are paramount for the ongoing evolution of laparoscopic nephrectomy into a standard of care.

REFERENCES