INTRODUCTION

At specialized centers worldwide, laparoscopic radical nephrectomy is now routine practice for management of indicated patients with localized renal cell carcinoma. Compared to open radical nephrectomy, the laparoscopic approach is associated with comparable operative time, decreased blood loss, superior recovery, improved cosmesis, and equivalent cancer control over an intermediate-term follow-up (1–4).

Laparoscopic radical nephrectomy is commonly performed by the transperitoneal approach, primarily because the transperitoneal route offers a larger working space. However, because the kidney is a retroperitoneal organ, a direct “retroperitoneoscopic” approach duplicates the established open surgical techniques, and has considerable appeal.
At the Cleveland Clinic, laparoscopic radical nephrectomy is preferentially performed by the retroperitoneal technique. Concerns about the smaller retroperitoneal working space notwithstanding, our learning curve has allowed us to readily overcome this technical difficulty. Furthermore, retroperitoneoscopy offers several unique advantages, including expeditious access to renal artery and vein allowing early ligation, extra fascial mobilization of the kidney, and en bloc removal of the adrenal gland, recapitulating the principles of open surgery (5). In fact, it is the senior author’s impression that graduating fellows from our institution are equally comfortable and adept at either the transperitoneal and the retroperitoneal laparoscopic approach to radical nephrectomy.

**PREOPERATIVE ASSESSMENT**

Attention to the patient’s cardiorespiratory status, coagulation profile, history of prior operations, and bone or spinal abnormalities is imperative. Our preoperative bowel preparation comprises two bottles of magnesium citrate administered the evening before the surgery. The patient reports to the hospital on the morning of surgery. Broad-spectrum antibiotics are administered intravenously 2 h preoperatively and intermittent compression stockings are placed bilaterally.

**NECESSARY INSTRUMENTATION**

- One 10-mm 30° laparoscope
- One 10-mm trocar-mounted balloon dissection device (U.S. Surgical, Norwalk, CT)
- One 10-mm Bluntip trocar (U.S. Surgical)
- Two 10–12-mm trocars
- One 5-mm electrosurgical monopolar scissors
- One 5-mm electrosurgical hook
- One 5-mm atraumatic grasping forceps (small bowel clamp)
- One 10-mm right-angle dissector
- One 10-mm three-pronged reusable metal retractor (fan-type)
- One 11-mm Endoclip applier
- One 12-mm articulated endo-GIA vascular stapler (U.S. Surgical)
- One 5-mm irrigator/aspirator
- One 15-mm Endocatch II bag (U.S. Surgical)
- One Weck clip applicator with disposable clip cartridges (Weck Systems)

**PATIENT POSITION**

Following general anesthesia and Foley catheter placement, the patient is firmly secured to the operating table in a 90° full flank position. All bony prominences are meticulously padded and extremities carefully placed in neutral position to minimize postoperative neuromuscular sequelae. The kidney bridge is elevated moderately, and the operating table is flexed somewhat to increase the space between the lowermost rib and the iliac crest. To guard against development of neuromuscular spinal problems, we make every attempt to minimize the time period for which the patient is placed in the lateral decubitus flexed position.

**OPERATION ROOM SETUP**

The surgeon and the camera operator (assistant) stand facing the patient’s back. The surgeon stands towards the patient’s feet, while the assistant stands toward the patient’s
head. The cart holding the primary video monitor, CO₂ insufflator, light source, and recorder is placed on the side of the table contralateral to the surgeon. The scrub nurse is positioned toward the foot end of the operative table.

PORT PLACEMENT

During radical retroperitoneoscopic nephrectomy, three trocars are placed. The laparoscope is positioned in the primary port at the tip of the 12th rib. The surgeon works through the posterior and anterior secondary ports (Fig. 1).

**Primary Port**

The open (Hasson cannula) technique is ideal for obtaining initial access. A horizontal 1.5-cm skin incision is made just below the tip of the 12th rib. Using S-shaped retractors, the flank muscle fibers are bluntly separated. Entry is gained into the retroperitoneal space by gently piercing the anterior thoracolombar fascia with the fingertip or hemostat. Limited finger dissection of the retroperitoneum is performed in a cephalad direction, remaining immediately anterior to the psoas muscle and fascia, and posterior to the Gerota’s fascia to create a space for placement of the balloon dilator (6). At this juncture the tip of the lower pole of the kidney can often be palpated by the finger. We insert a trocar-mounted balloon dissection device (Origin Medsystems, Menlo Park, CA) for rapidly and atraumatically creating a working space in the retroperitoneum in a standardized manner (Fig. 2). The volume of air instilled into the balloon is typically 800–1000 mL in adults (40 pumps of the sphygmomanometer bulb). The balloon dilatation outside Gerota’s fascia (i.e., in the pararenal space between the psoas muscle posteriorly and Gerota’s fascia anteriorly) effectively displaces the Gerota’s fascia covered kidney anteromedially, allowing direct access to the posterior aspect of the renal hilum (Fig. 3). Laparoscopic examination from within the transparent balloon confirms adequate expansion of the retroperitoneum. Secondary cephalad or caudal balloon dilatation, as required by the clinical situation, further enlarges the retroperitoneal working space. For example, during a retroperitoneoscopic

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**Fig. 1.** Port placement during right retroperitoneoscopy radical nephrectomy. (A) primary 10-mm port is placed at the tip of 12th rib. (B) 10-/12-mm port is placed at junction of lateral border of the erector spinae muscle with underside of 12th rib. (C) 10-12-mm port is placed three fingerbreadths cephalad to iliac crest, between mid and anterior axillary lines.
adrenalectomy the balloon is deflated and reinflated in a more cephalad location along
the undersurface of the diaphragm to create a working space in the immediate vicinity
of the adrenal gland. Similarly, during a retroperitoneoscopic nephroureterectomy,
secondary balloon dilation is performed caudally to expose the distal ureter.

Following balloon dilatation and removal, a 10-mm Bluntip trocar (Origin Medsys-
tems) is placed as the primary port (Fig. 4). This trocar has an internal fixed fascial
retention balloon and an external adjustable foam cuff, which combine to eliminate air
leakage at the primary port site. The internal fascial retention balloon of the cannula
is inflated with 30 cc of air, and the external adjustable foam cuff is cinched down
to secure the primary port in an airtight manner (7). In the author’s experience, such
an airtight seal has been more difficult to achieve with a standard Hasson cannula.
Pneumoretroperitoneum is established to 15 mmHg, and a 10-mm, 30° laparoscope
is inserted. The psoas muscle and Gerota’s fascia are identified immediately. In our
experience (8), one or more of these landmarks are identifiable in the following
frequency: lateral peritoneal reflection (83%), ureter and/or gonadal vein (61%),
pulsations of the fat-covered renal artery (56%), aortic pulsations of the left side (90%),
and the compressed, ribbon-like inferior vena cava on the right side (25%).

Secondary Ports

Two secondary ports are placed under 30° laparoscopic visualization. The immedi-
ately adjacent undersurface of the flank abdominal wall is visualized endoscopically.

Fig. 2. Trocar-mounted preperitoneal dilator balloon (uninflated and inflated) device (Origin
Medsystems).
Fig. 3. Balloon dilator positioned between psoas fascia posteriorly and Gerota’s fascia anteriorly. The distended balloon (800 cc) displaces Gerota’s fascia/kidney antero-medially allowing access to renal vessels.

Fig. 4. A Bluntip trocar (Origin Medsystems) is employed to achieve an airtight seal for the primary port.
A 10-/12-mm port is placed 3 fingerbreadths cephalad to the iliac crest, between the mid and anterior axillary lines. A second 10-/12-mm port is placed at the lateral border of the erector spinae muscle just below the 12th rib. Frustrating “clashing of swords” occurs if the trocars, and therefore the laparoscopic instruments, are located in close proximity. Thus, the port placed between mid and anterior axillary lines can be positioned even more anteriorly to the anterior axillary line; however, the lateral peritoneal reflection must be clearly visualized laparoscopically and avoided before the port is inserted. If necessary, the lateral peritoneal reflection can be bluntly mobilized further anteriorly from the undersurface of the flank abdominal wall using the laparoscope’s tip.

**STEP-BY-STEP SURGICAL APPROACH**

**Renal Hilum Control**

The kidney is retracted anterolaterally with a laparoscopic small bowel clamp or the fan retractor in the nondominant hand of the surgeon placing the renal hilum on traction. Gerota’s fascia is incised longitudinally in the general area of the renal hilum, parallel and 1- to 2-cm anterior to the psoas muscle. Care must be taken to avoid dissection close by the psoas muscle, which may lead the surgeon to reach the retrocaval or the retroaortic space. The longitudinal incision of the Gerota’s fascia opens the retroperitoneal space, thereby adding to the effect of the carbon dioxide insufflation, and exposing the renal hilum. Blunt and sharp dissection in this avascular area of loose areolar fatty tissue is performed to identify renal arterial pulsations. Visualization of the vertically oriented, distinct arterial pulsations indicates the location of the renal artery, which is circumferentially mobilized, clip-ligated (11-mm titanium clips; three on the “stay side” and two on the “go side”) and divided. Subsequently, the renal vein, is stapled and divided with an Endo-GIA stapler (U.S. Surgical) (Fig. 5). Usually after division of the renal vein, some flimsy hilar attachments remain between the kidney and the great vessels. In order to avoid traction injury, which may lead to venous tear and bleeding, these remaining attachments should be precisely clipped and transected.

**Intraoperative Trouble-Shooting**

**Problems with Orientation in the Retroperitoneum**

To avoid problems with orientation in the retroperitoneum, the camera should be oriented such that the psoas muscle is always absolutely horizontal on the video monitor (5). However, the retroperitoneal space is relatively small at this stage of the procedure, anteromedial retraction of the kidney serves to increase the retroperitoneal space, exposing the psoas muscle that can be identified most easily caudal to the kidney.

**Difficulty in Finding the Renal Hilum**

If the renal hilum cannot be located, the surgeon should reinsert the laparoscope slowly and identify the psoas muscle. The psoas muscle should then be crossed from lateral-to-medial in a cephalad direction and a search conducted for arterial pulsation near its medial border. Pulsations of the fat-covered renal artery or aorta are usually identifiable. Gentle dissection with the tip of the suction device or hook is performed directly toward the pulsations. The renal artery is identified and traced directly to the renal hilum. One must always be mindful of aberrant major vessels, such as the superior mesenteric artery, which arises from the aorta more medially and superiorly than the
left renal artery. Alternatively, the ureter can be identified and followed cephalad to the hilum. Dissection through the perirenal fat may identify the surface of the kidney, which can then be dissected toward its hilum.

**Persistent Renal Hilar Bleeding after Division of the Renal Artery and Vein**

Persistent renal hilar bleeding generally indicates the presence of an overlooked, accessory renal artery. After flow is controlled from the main renal artery, the renal vein should appear flat and devoid of blood. A normally distended renal vein at this juncture indicates continued arterial inflow through an accessory renal artery. In this circumstance, division of the distended renal vein with an Endo-GIA stapler (U.S. Surgical) interrupts renal outflow, with a resultant increase in intrarenal venous back pressure. This causes persistent ooze during the remainder of the dissection. One should search for an accessory renal artery in this situation.

**Endo GIA Malfunction**

The GIA stapler is standard for control of renal hilar vessels. However, failure of the device can be associated with severe consequences, including emergency conversion to open procedure.

The most common cause of GIA failure is inadvertent placement of the device over a previously placed surgical clip (10). In order to avoid this situation, extreme care must be taken when positioning and firing the Endo GIA stapler in the presence of surgical clips in the area of renal hilum.

**Circumferential Extrafascial Mobilization of the En Bloc Specimen**

Suprahilar dissection is performed along the medial aspect of the upper pole of the kidney and the adrenal vessels, including the main adrenal vein, are precisely controlled.
with clip-ligation. Dissection is next redirected towards the supralateral aspect of the specimen, including en bloc adrenal gland, which is readily mobilized from the underside of the diaphragm. In the avascular flimsy areolar tissue in this location, inferior phrenic vessels to the adrenal gland are often encountered and controlled. The anterior aspect of the specimen is mobilized from the underside of the peritoneum envelope. During this dissection, use of electrocautery must be avoided in order to avoid transmural thermal damage to the bowel located just beside the thin peritoneal membrane. The ureter, with or without the gonadal vein, is secured, and the specimen is completely freed by mobilization of the lower pole of the kidney. The entire dissection is performed outside Gerota’s fascia, mirroring established oncologic principles of open surgery.

**INTRAOPERATIVE TROUBLE-SHOOTING**

**Inadvertent Peritoneotomy**

A peritoneotomy does not necessarily mandate conversion to transperitoneal laparoscopy. Usually, a peritoneal rent does not cause significant problems, and the procedure can be completed retroperitoneoscopically. However, if operative exposure is compromised, a fourth port can be inserted to provide additional retraction of the billowing peritoneal membrane.

Also, intra-abdominal viscera must be thoroughly inspected by inserting the laparoscope through the peritoneotomy to rule out iatrogenic injury.

**SPECIMEN ENTRAPMENT**

Organ entrapment is rapidly performed by using an Endocatch bag (U.S Surgical). This bag is an impermeable plastic and nylon sac designed to prevent tumor spillage during intact specimen removal. This bag should never be employed during tissue morcellation \(^{(11)}\). The specimen is tented up by the nondominant hand. The bag is introduced through the anterior port, the spring-loaded mouth of the sac is opened in the retroperitoneum, and the specimen placed within. After specimen entrapment, the mouth of the bag is detached from the metallic ring and closed (under laparoscopic visualization) by tightening the drawstring (Fig. 6).

**Entrapment of Larger Specimens**

An intentional peritoniotomy is occasionally created, strictly for entrapment of large specimens. The large specimen is inserted within the peritoneal cavity where it is entrapped within the 15-mm Endocatch II bag (U.S. Surgical).

**SPECIMEN EXTRACTION**

Currently our routine practice for specimen extraction aims to achieve a superior cosmetic result while providing an intact specimen for precise pathologic staging. In this manner, we employ for the male patient a low muscle-splitting Pfannensteil incision \(^{(12)}\) and for the appropriate female patient a vaginal extraction \(^{(13)}\) of the specimen.

**Specimen Extraction in Males**

A Pfannensteil skin incision (slightly lateralized towards the nephrectomy side) is made at or just below the level of the pubic hairline. Subsequently the anterior rectus
fascia is incised obliquely, rectus muscle fibers are retracted medially, posterior rectus fascia is incised, the peritoneal membrane is reflected cephalad using finger dissection, and extraperitoneal access is gained to the retroperitoneal space, to extracted the intact entrapped specimen (Fig. 7).

**Specimen Extraction in Females**

After the specimen is entrapped in an Endocatch II bag, a generous longitudinal peritoneotomy is intentionally created along the undersurface of the anterior abdominal wall. The operating table is placed in a steep Trendelenburg position, and rotated such that the flank position is decreased to 60°. Bowel loops are retracted cephalad.

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**Fig. 6.** After specimen entrapment, mouth of bag is detached from metallic ring and closed by pulling on built-in drawstring.

**Fig. 7.** A Pfannenstiel skin incision (at or just below the level of the pubic hairline) is used to retrieve the intact specimen entrapped in a bag.
A sponge-stick is externally inserted into the sterilely prepared vagina and tautly positioned in the posterior fornix. Laparoscopically, a transverse posterior 3-cm colpotomy is created at the apex of the tented-up posterior fornix, and the drawstring of the entrapped specimen is delivered into the vagina (Fig. 8). After laparoscopic exit is completed, the patient is placed in a supine lithotomy position. The specimen is extracted intact per vaginum, and the posterior colpotomy incision repaired transvaginally. This approach is contraindicated in patients with even a mild degree of pelvic or intraperitoneal adhesions from any etiology.

HEMOSTASIS

Hemostasis is confirmed under lowered retropneumoperitoneum (Fig. 9) and ports are removed under laparoscopic visualization. Fascial closure is performed for all 10-mm or larger port sites.

SPECIAL CONSIDERATIONS

Concerns about Tumor Size

Because our initial approach is targeted towards the renal hilum, the size of the renal mass only becomes a significant issue only at the time of specimen mobilization. In our series, 33% of the tumors were equal to or larger than 6 cm on CT scan (Fig. 10), including tumors up to 13–14 cm in size with overall specimen weight exceeding 1.5 kg.

Retroperitoneoscopy in Obese Patients

Although the excessive retroperitoneal fat increases the degree of technical difficulty, adherence to a standardized stepwise anatomical approach (14) allows retroperitoneoscopy to be performed effectively in markedly obese or morbidly obese patients. In fact, the retroperitoneal flank approach allows the gravitational pull to shift much of the
weight of the pannus anteriorly, away from the ipsilateral flank (Fig. 11). In our series, 35% of the patients had body mass index (BMI) equal or greater than 30. However, the reader should be cautioned that these challenging procedures should be performed by surgeons facile with the laparoscopic technique.

**Preservation of the Adrenal Gland (if Necessary)**

To preserve the adrenal gland, Gerota’s fascia is opened and a well-defined plane between the upper pole of the kidney and the adrenal is dissected using electrosurgical

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**Fig. 9.** Hemostasis of the renal bed is confirmed after 5–10 min without CO$_2$ pressure in the retroperitoneal space. Trocars are removed under laparoscopic visualization.

**Fig. 10.** Retroperitoneoscopic radical nephrectomy. This surgical specimen weighed 1200g.
In our series, en bloc adrenalectomy was not performed in 33 cases (30.5%). These included cases from bilateral radical nephrectomy, previous contralateral adrenalectomy, or elective preservation of the adrenal gland.

**Oncologic Efficacy of Retroperitoneoscopy**

Laparoscopic retroperitoneal surgery for renal tumor does not result in an increased risk of port site seeding, local recurrences, or metastasis (15). To achieve oncological

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**Fig. 11.** With patient in a full-flank position a significant amount of the abdominal pannus falls away from operative side. This patient had a BMI of 47.5.

**Fig. 12.** If necessary, the adrenal gland can be preserved. Gerota’s fascia is opened and adrenal is detached from the upper renal pole using electrocautery scissors.
safety, the classical rules of renal cancer surgery must be respected. Also the surgical specimen must be removed in a hermetic sac to avoid any contact between the abdominal wall. We prefer intact specimen extraction so as to allow precise pathologic staging. If morcelation is employed, care should be taken to guard against rare complications such as sack perforation and tumor spillage (16,17).

**TAKE HOME MESSAGES**

1. Compared with transperitoneal laparoscopy, retroperitoneoscopy may be associated with a somewhat sharper learning curve.
2. For efficacious performance of retroperitoneoscopic surgery, proper development of the retroperitoneal space and constant orientation with various anatomical landmarks is critical. It is abundantly clear that the retroperitoneal space can be readily developed and enlarged appropriately as the laparoscopic dissection proceeds.
3. Although out of sight, peritoneal organs must never be out of mind, because they are separated only by the peritoneal layer, and therefore are susceptible to injury.
4. Retroperitoneoscopy does offer significant advantages. Foremost is the straightforward and rapid exposure and control of the renal hilum, and nonviolation of the peritoneum, thus minimizing the chances of intraperitoneal organ injury. In our experience, the operating time is shorter, paralytic ileus is minimal, hospital stay is usually overnight, and recovery is rapid (18).

**REFERENCES**
