

**OPERATIVE UROLOGY
AT THE CLEVELAND CLINIC**

OPERATIVE UROLOGY

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 HUMANA PRESS
TOTOWA, NEW JERSEY

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999 Riverview Drive, Suite 208
Totowa, New Jersey 07512

humanapress.com

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Production Editor: Robin B. Weisberg

Cover Illustration: From the top down: (1) Partial nephrectomy wedge (original artwork created for the cover by the Cleveland Clinic Foundation); (2) Figure 16E, Chapter 24; (3) Open approach to bladder suspension (original artwork created for the cover by the Cleveland Clinic Foundation); (4) Figure 14, Chapter 35.

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Printed in the United States of America. 10 9 8 7 6 5 4 3 2 1

eISBN 1-59745-016-2

Library of Congress Cataloging-in-Publication Data

Operative urology at the Cleveland Clinic / senior editor, Andrew C. Novick ; associate editor, J. Stephen Jones ; section editors, Inderbir S. Gill [et al.].

p. ; cm.

Includes bibliographical references and index.

ISBN 1-58829-081-6 (alk. paper)

I. Genitourinary organs--Surgery. I. Novick, Andrew C. II. Jones, J. Stephen, 1960- . III. Gill, Inderbir S. IV. Cleveland Clinic Foundation. [DNLM: 1. Urologic Surgical Procedures--methods. WJ 168 O616 2006]

RD571.O6672 2006

617.4'6--dc22

2005019741

Preface

More than 125 years have passed since the basic contributions of John Hunter, Crawford Long, and Lord Lister transformed surgery into a sound science as well as a delicate art. Several great surgeons in later decades established basic principles of management that remain valid to this day. As more knowledge was gained, surgical specialties and subspecialties evolved and grew. This has been particularly true in urology, where the surgical approach to many problems has changed significantly in recent years.

The Cleveland Clinic Glickman Urological Institute houses more than 50 full-time urological clinicians and surgeons with in-depth expertise in both general urology and every urological subspecialty area. *Operative Urology at the Cleveland Clinic* encompasses the entire field of urological surgery and is authored exclusively by our distinguished faculty. This compendium provides detailed step-by-step well-illustrated descriptions of all commonly performed inpatient and outpatient urologi-

cal operations including newer approaches such as laparoscopic and minimally invasive surgery. The various chapters have been organized according to specific diseases or clinical problems. This enables the reader interested in a particular surgical problem, such as kidney cancer or bladder cancer, to find all the relevant approaches and information within a single chapter or section of the book.

This book reflects the philosophy of the Cleveland Clinic Glickman Urological Institute that urology is a broad surgical discipline that encompasses all operations that relate centrally or peripherally to the genitourinary tract and male reproductive organs. We hope that our efforts have yielded a comprehensive and practical reference source for practitioners and residents that will ultimately improve the care of patients with urological surgical problems.

A full text version of the book is available on DVD and sold separately (ISBN 1-59745-371-4).

*Andrew C. Novick, MD
For the editors*

Acknowledgments

This monumental work was created through the diligence and creativity of some of the most accomplished experts in the field of urology. First and foremost are the authors whose dedication both to the science and to this book allowed us to assemble one of the most complete surgical urology atlases ever published, and certainly the largest ever published by a single institution. Second, the talented artists of the Cleveland Clinic Medical

Illustrations Department have created a work of art over and above its scientific merit. More importantly, they have interpreted clinician's words and photographs into an almost life-like instrument of surgical learning. Finally, Marge O'Malley and the administrative and secretarial staff of the Glickman Urological Institute devoted endless hours to this project, allowing its smooth, timely publication.

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The Kidney and Adrenal

1 Surgical Incisions

J. Stephen Jones

The purpose of any surgical incision is facilitation of the planned operation with the least possible morbidity. As most urological operations can be performed via many different approaches, the surgeon must combine understanding of all alternatives with the flexibility to choose the incision most appropriate to each clinical situation. The selection may make the difference between an easy or difficult operation, which will affect the experience of both the patient and surgeon.

GENERAL CONSIDERATIONS

Urological organs can be approached via multiple routes. For example, the kidney can be accessed through transabdominal incisions (subcostal, midline, paramedian), flank incisions (through or between the beds of the lowest three ribs, or lumbodorsal), a combination of the two (thoracoabdominal), or laparoscopically. The surgeon should choose based on operation-specific and patient-specific factors.

Operation-specific issues depend on the surgical goals. Larger incisions, especially those that allow access to the entire coelom, give more exposure at the cost of additional morbidity and cosmetic impact. Whereas one might prioritize wide exposure and choose a thoracoabdominal incision for a large renal mass with caval involvement, an extraperitoneal flank incision gives adequate exposure with less morbidity for pyeloplasty or routine nephrectomy.

Avoidance of involving additional body cavities, particularly if infection is present, may play a role in decision making. For example, extraperitoneal flank incision for an infected renal calculus or abscess minimizes the risk of contaminating the peritoneal cavity or thorax.

Patient-specific cosmetic or anatomical considerations are often overlooked. Some patients may resist surgery if they perceive disfigurement. Other patient-specific factors to be considered include scarring or adhesions from radiation or previous surgery. Abdominal access in a patient with a stoma or neobladder may require creatively avoiding a midline incision. Artificial material (e.g., urinary prostheses,

vascular grafts, or abdominal mesh) must be carefully considered prior to violating these structures.

Body habitus often influences choice of incision. The dictum, “No one is fat in the flank,” results from the observation that a large pannus will fall forward when the patient is placed in the standard flank position. Therefore, nephrectomy on a morbidly obese patient can be easier to perform via a flank incision than it would be through a subcostal. Open nephroureterectomy traditionally requires both a flank and a lower abdominal incision. However, a single extended subcostal extraperitoneal flank incision may allow complete removal of the kidney, entire ureter, and bladder cuff in a thin woman with a short waist and wide pelvis. This can save time and avoid potential wound contamination during patient repositioning and draping.

Severe kyphosis or scoliosis may make surgical approaches more or less difficult. Whereas left scoliosis might make left flank incision difficult, the right side might actually be easier than usual owing to the splaying of the ribs away from the iliac crest.

Concurrent pathology may affect the decision. If a patient has gallbladder disease and a large right renal cancer, both organs may be removed through a subcostal incision. A flank incision followed by laparoscopic cholecystectomy may be chosen if the pathology is in the contralateral kidney.

Excessive incisional length increases the discomfort and cosmetic impact, whereas an undersized incision may make an otherwise easy operation a struggle. Matching the skin incision to the fascial opening assures the scar is only as long as required, but fascial closure is not compromised on either end.

Utilizing the entire incision also requires appropriate retraction. The Buchwalter retractor is useful in most flank and abdominal incisions, as it gives a fixed exposure and does not tire like a surgical assistant. Alternatively, other self-retaining retractors like the Finochietto or Balfour work well for oppositional retraction but do not offer multidirectional retraction.

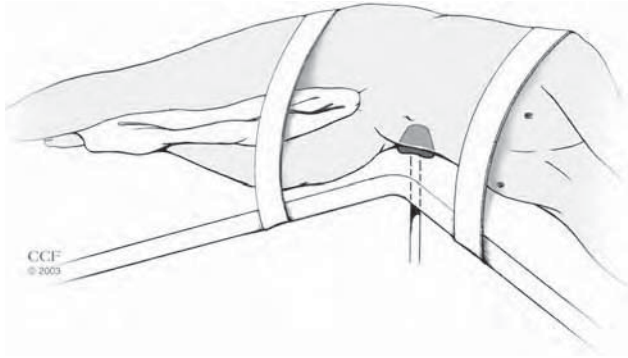


Fig. 1.1 (Front View)

INCISIONS FOR EXPOSURE OF THE UPPER GENITOURINARY ORGANS

Flank Approaches

A flank incision offers extraperitoneal access to the kidney and adjacent structures. However, access to the hilar structures may be limited, especially in the presence of large tumors. Experienced surgeons rarely find this limitation bothersome if exploration of other intra-abdominal structures is not required.

Nowhere is proper positioning more important than for flank incisions. This is achieved by placing the patient in the lateral decubitus position after induction of anesthesia. A towel roll or bag of intravenous fluid is placed under the axilla to protect against brachial nerve palsy. An electrically controlled surgical bed is helpful, especially during closure of the incision when a hand crank will likely hit the arm board. The dependent leg is flexed, with pillows placed between the legs to protect pressure points. The upper leg is almost straight, crossing the mid-calf of the lower leg. The lower arm is placed on an arm board. A double arm board or instrument stand may support the upper arm.

The patient's waist should be directly over the kidney rest. Extend the table at the waist only after the kidney rest is fully elevated. Correct bed extension occurs when

the abdominal muscles at the waist demonstrate tension, bringing them into parallel with the floor. The ribs can be palpated and marked in all but the most obese patients.

ELEVENTH RIB INCISION (CLASSIC FLANK)

Although a flank incision can be made through or between the beds of the lowest three ribs, removal of the 11th rib usually offers excellent exposure and minimizes risk of entering the pleura.

The incision begins posteriorly at the angle of the rib and may extend as far as the border of the rectus abdominus. The skin and subcutaneous tissues are opened to expose the latissimus overlying the chosen rib. Transecting the overlying muscle exposes the periosteum, which can be incised along the length of the rib using the electrocautery or scalpel.

A periosteal elevator is used to remove the periosteum to the point where it wraps above and below the rib. Care must be taken caudally to stay between rib and periosteum to avoid injuring the neurovascular bundle running along the rib notch.

The opposite end of the Alexander periosteal elevator is shaped to allow detachment of the intercostal fibers on the upper and lower rib margins. Because of the directional attachment of the fibers, pulling the instrument "up on the down side and down on the up side" mobilizes the rib borders.

The Doyen rib instrument slides into the plane between rib and periosteum. The instrument is then pulled in each direction along the rib to complete the rib dissection. If the instrument is placed too deeply, bleeding from the neurovascular bundle and pleural injury are likely.

A rib cutter divides the rib posteriorly. Rongeur scissors remove any bony spicules. Marrow bleeding is usually minimal.

Anteriorly the rib must be separated from the costal margin using electrocautery or heavy scissors.

Blunt dissection through the remaining fibers in the anterior rib bed exposes the retroperitoneum. Care is taken to mobilize the pleura for cephalad retraction. If

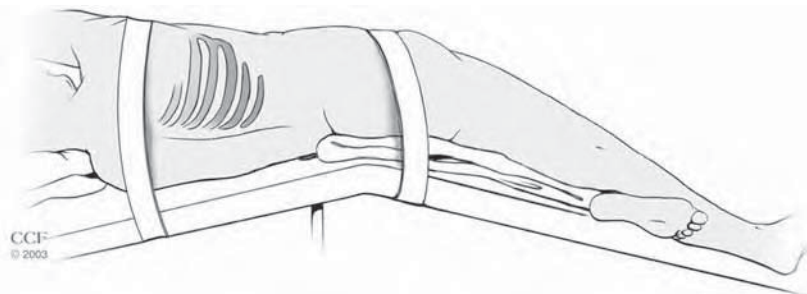


Fig. 1.2 (Back View)

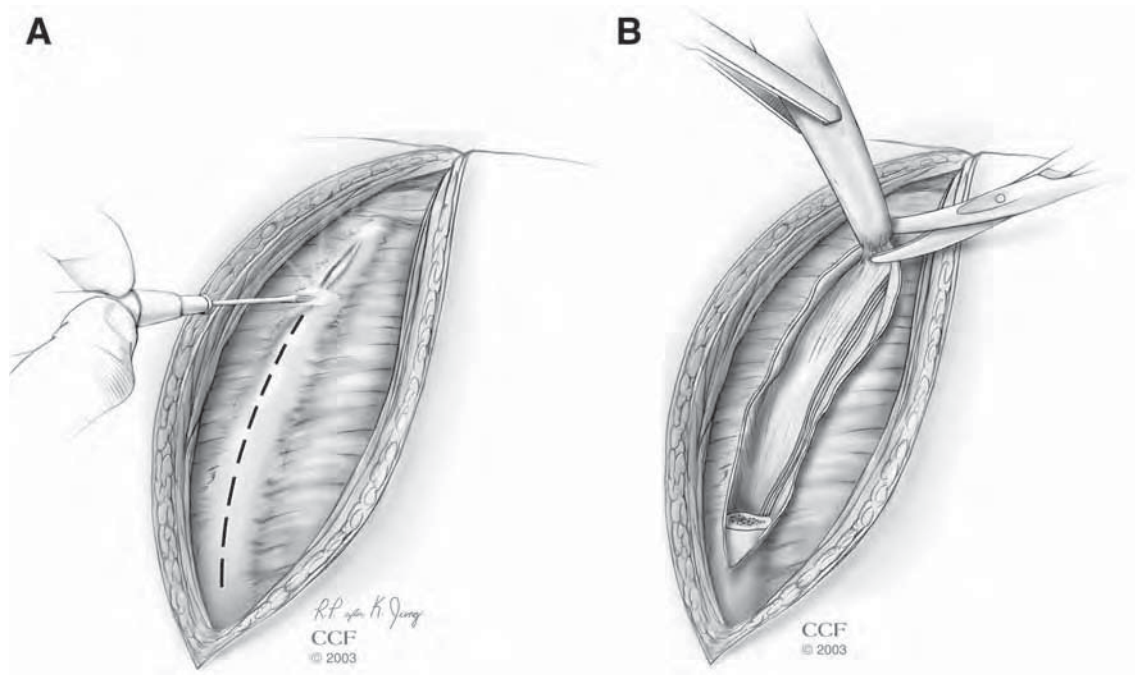


Fig. 1.3

entered, the pleura is closed at the end of the procedure after aspirating air from the thorax using a red rubber catheter.

After bluntly sweeping the peritoneum anteriorly off the abdominal wall, the muscular layers may be divided between fingers using the electrocautery.

SUBCOSTAL FLANK INCISION

If there is no need for high exposure, a flank incision can be made below the 12th rib. This eliminates the risk of entering the pleural cavity, but is no less painful than a rib incision. The incision is especially useful in children.

A formal flank position is used. After marking the tips of the lower ribs with a surgical pen, it is helpful to draw the position of the 12th thoracic nerve, also known as the subcostal nerve. The incision extends from sacrospinalis muscle posteriorly to the rectus border anteriorly.

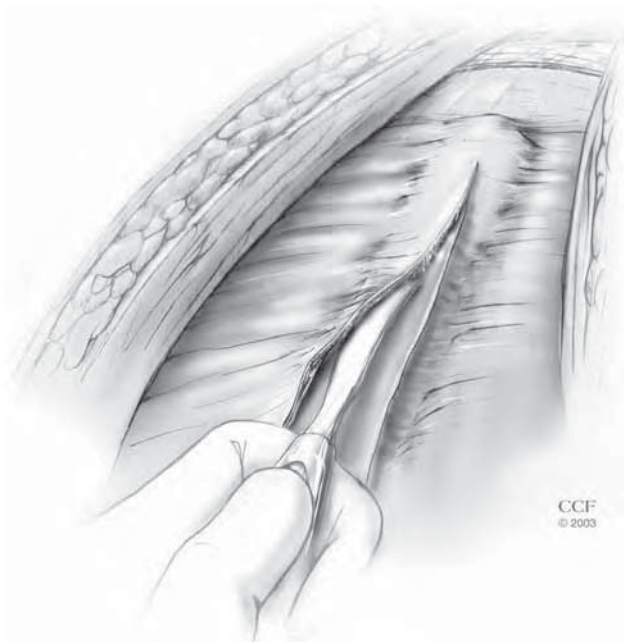


Fig. 1.4

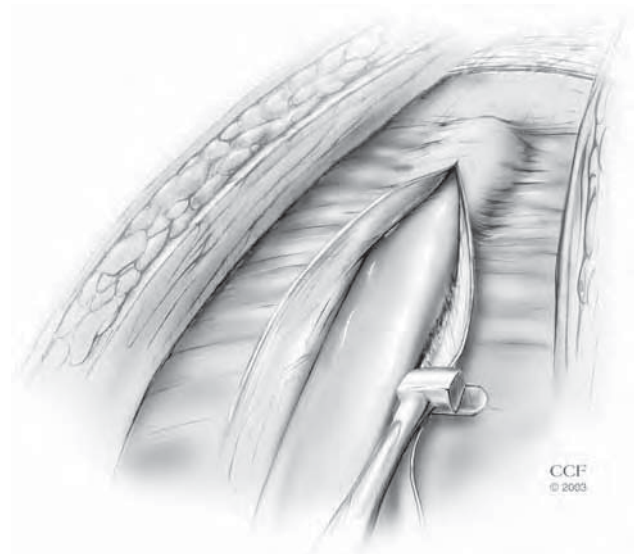


Fig. 1.5

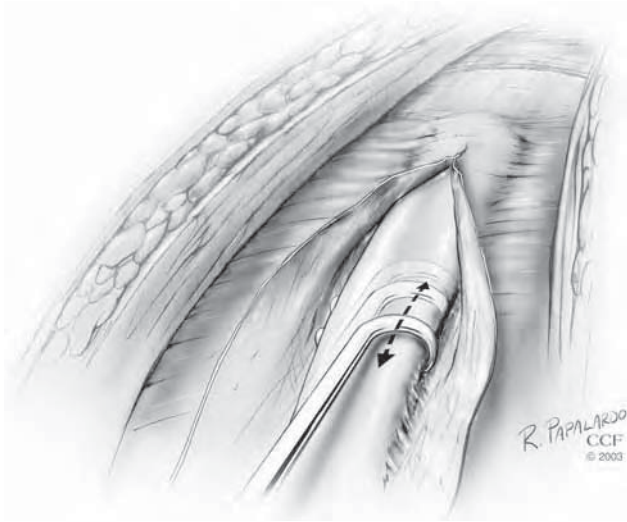


Fig. 1.6

The skin and subcutaneous tissues are opened to expose the external abdominal oblique muscle and latissimus dorsi. Care must be taken opening the internal oblique in order to avoid damaging the subcostal nerve, which lies between the internal abdominal oblique muscle and the underlying transversalis abdominus.

Careful mobilization of the subcostal nerve and vessels allows them to be retracted either cephalad or caudad. The lumbodorsal fascia (the fusion of the internal oblique and transversalis muscle sheaths posteriorly) is incised to enter the retroperitoneum. Peritoneum is then swept away from the anterior abdominal wall. The transversalis fibers are separated bluntly.

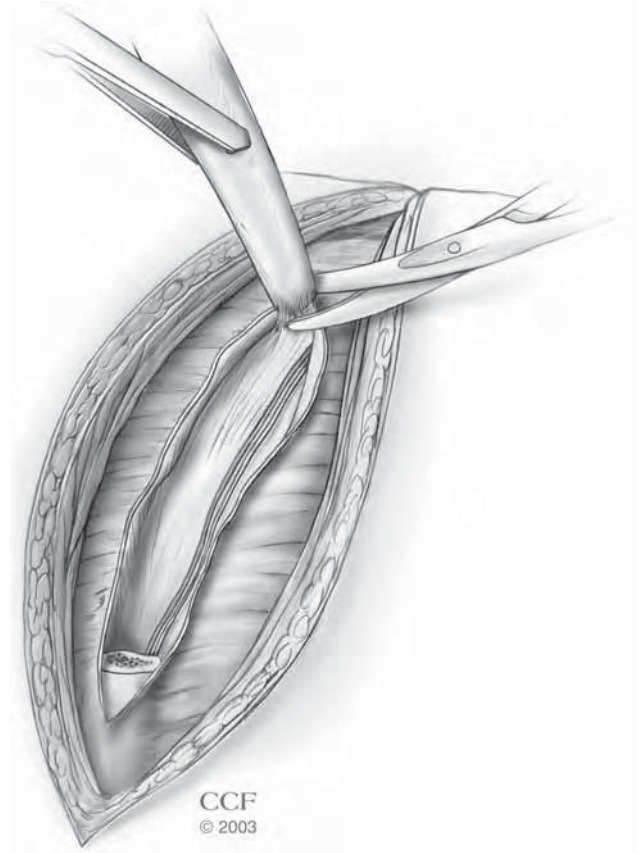


Fig. 1.8

DORSAL LUMBOTOMY

This incision is used infrequently, but in properly selected thin patients it offers relatively atraumatic access to the ureteropelvic junction (UPJ). The incision is limited



Fig. 1.7

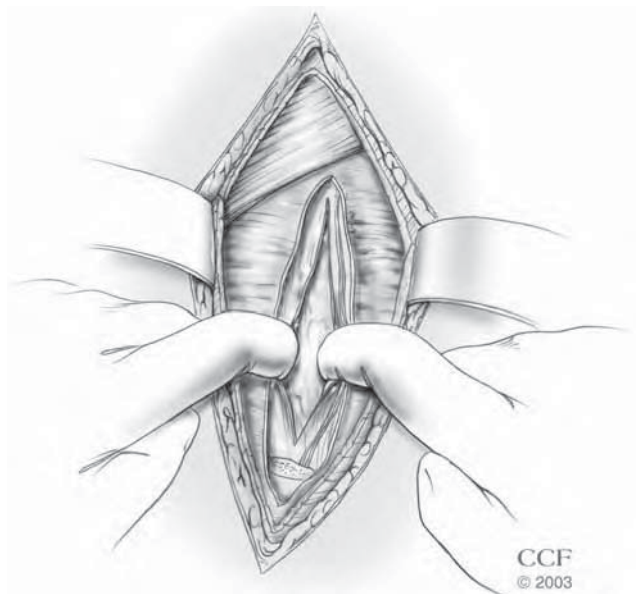


Fig. 1.9

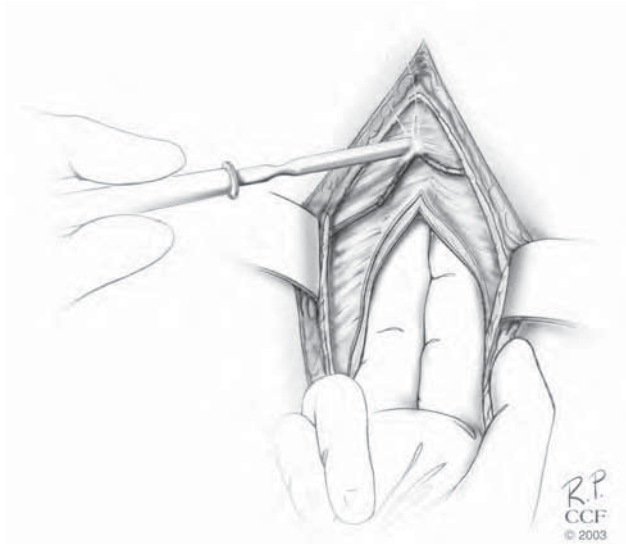


Fig. 1.10

by the 12th rib superiorly and the iliac crest inferiorly, so there is no option to extend it; therefore, it should be used only when the access needed is undoubtedly within this narrow window.

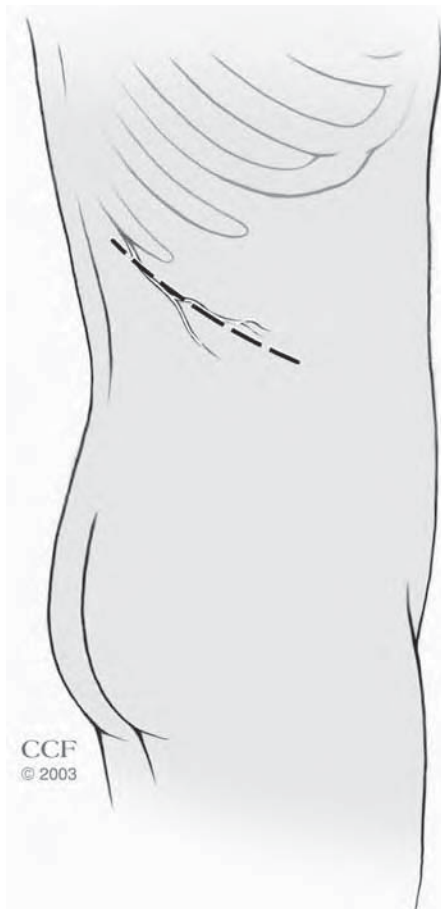


Fig. 1.11

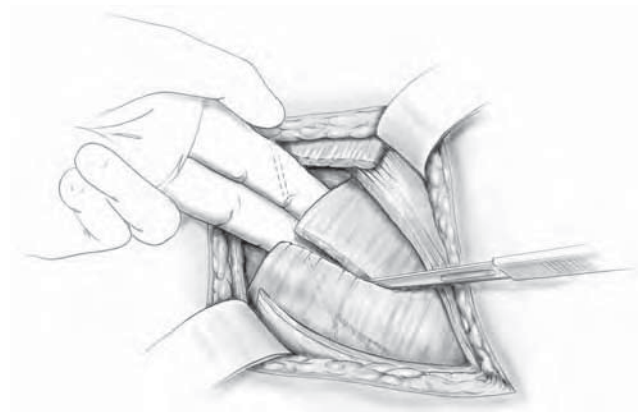


Fig. 1.12

The incision follows the lateral border of the paraspinal muscles from the 12th rib to iliac crest. Rolled sheets support the shoulders with the patient prone. A small amount of bed extension increases the distance between the bony limits.

After opening the skin and subcutaneous tissues, the lumbodorsal fascia is identified. The medial aspect is bordered by the paraspinal muscles and quadratus lumborum. The lateral aspect is bordered by the latissimus dorsi. Dividing the lumbodorsal fascia exposes Gerota's fascia. Because the space is small, the incision may be best visualized with handheld retractors. The UPJ and upper ureter are easily mobilized through a window in Gerota's fascia.

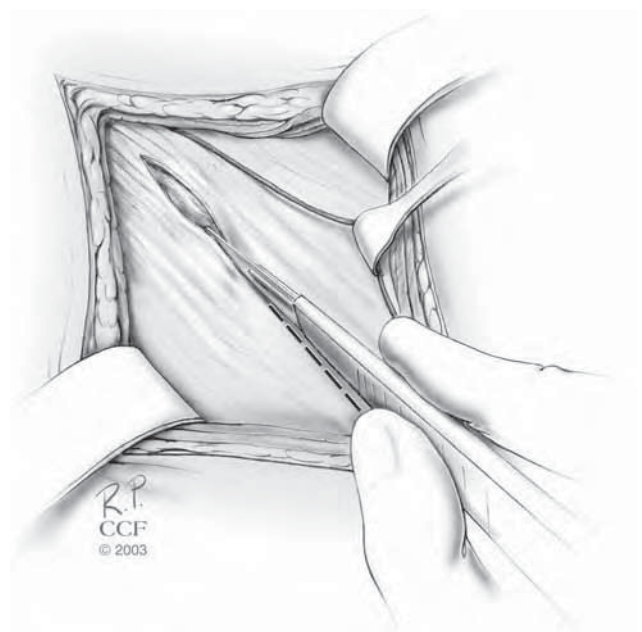


Fig. 1.13

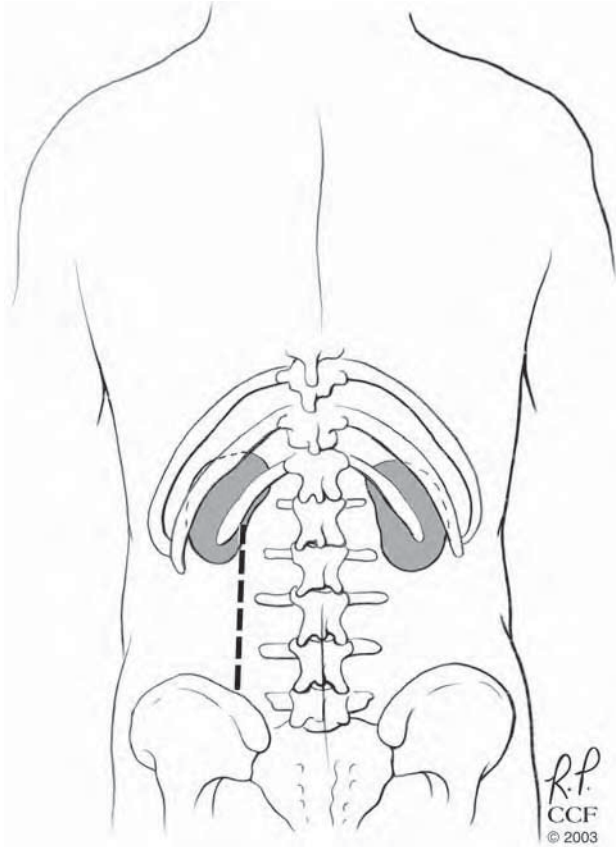


Fig. 1.14

Anterior Approaches

Excellent exposure and ready access to the renal hilum are advantages of intra-abdominal anterior approaches. Disadvantages include the higher incidence of ileus and incisional hernia.

SUBCOSTAL TRANSPERITONEAL INCISION

The patient is placed in the supine position with the bed extended below the lumbar spine. A blanket elevating the ipsilateral shoulder enhances lateral extension. The skin is prepped all the way to the bed.

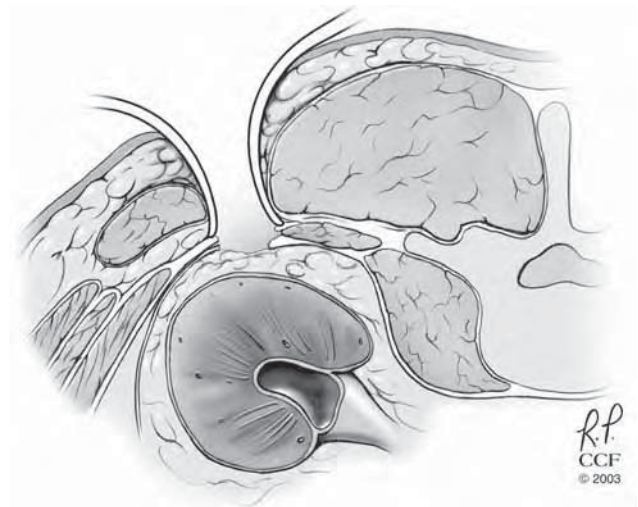


Fig. 1.15

The skin incision is made two fingerbreadths below the costal margin from the anterior axillary line to slightly across the midline. The external oblique, internal oblique, and transversalis muscles are opened laterally. Their fasciae briefly join lateral to the rectus abdominus muscle. At that point, the rectus fascia splits anteriorly and posteriorly. In patients without extensive intra-abdominal scarring, an effective approach is to enter the peritoneal cavity in the midline portion of the incision under direct visualization. Properitoneal fat should be swept off the peritoneum, which is grasped with tissue forceps and held up to allow the underlying omentum and small bowel to fall away prior to cutting between the forceps (inset, Fig. 1.17).

Two fingers are placed under the abdominal wall to protect the underlying small bowel. The abdominal wall is then opened under direct vision, ligating the branches of the superior epigastric artery. The falciform ligament holds the ligamentum teres, which is the remnant of the umbilical vein. In patients with adhesion of peritoneal contents to the abdominal wall, the dissection into the abdomen should be done with a combination of blunt and sharp dissection. Lateral

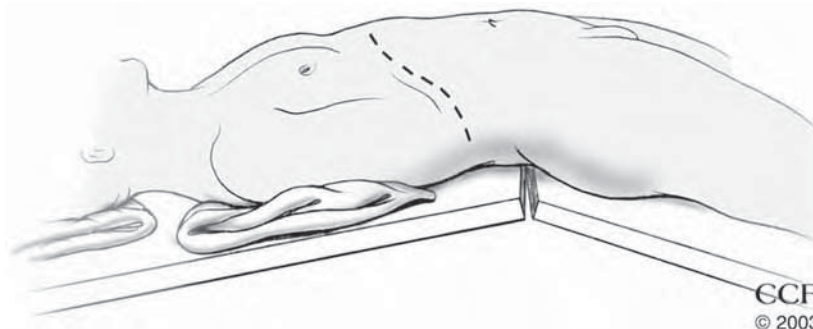


Fig. 1.16

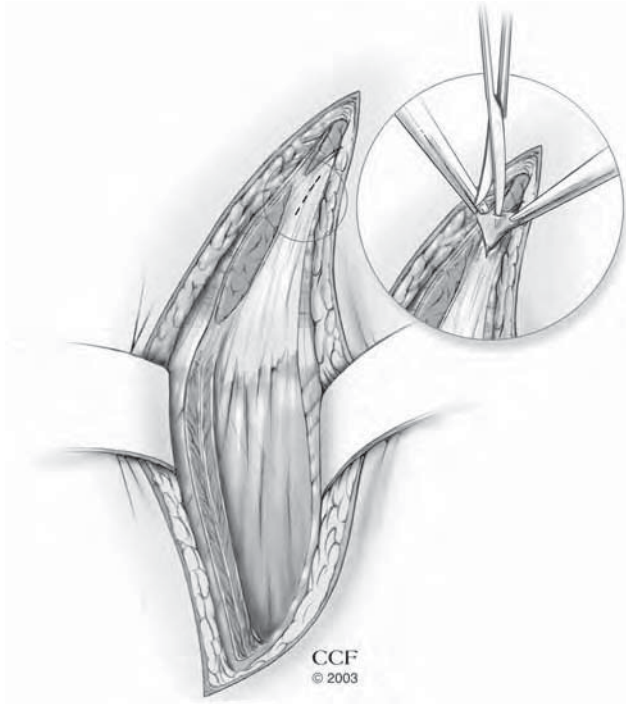


Fig. 1.17

entry sometimes avoids these adhesions. The incision ends posterolaterally near the peritoneal reflection of Toldt.

BILATERAL SUBCOSTAL TRANSPERITONEAL INCISION

Excellent exposure to the upper abdominal cavity and retroperitoneum is afforded through this incision, otherwise known as a chevron or “bucket-handle” incision.



Fig. 1.18

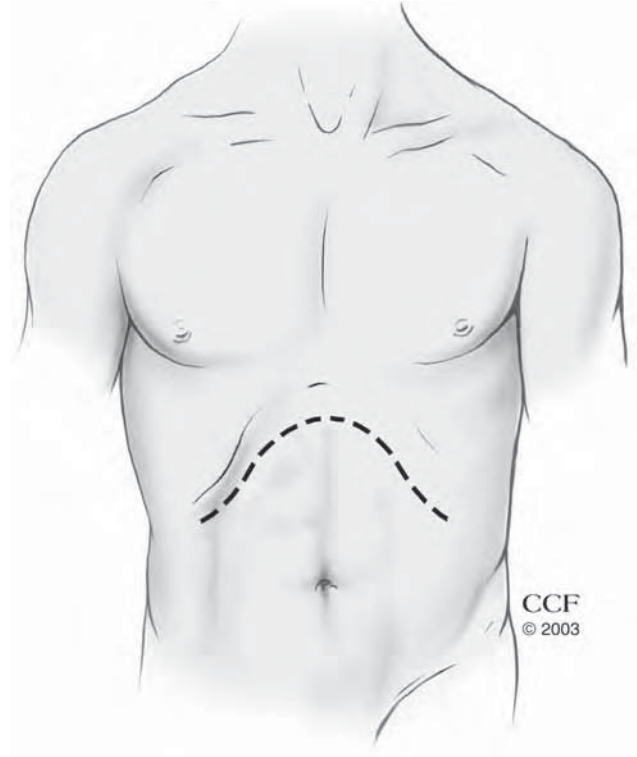


Fig. 1.19

The patient’s waist is positioned over the flexion point of the surgical bed. Arms may be tucked at the patient’s side, but if the dissection is planned beyond the anterior axillary line, they should be placed on arm boards. Table extension increases exposure as long as caval compression by stretching is avoided.

As with any bilateral incision, care should be taken to assure the incision is symmetrical with respect to the midline and to the costal margins. The abdomen is entered in the same manner as in the unilateral subcostal transperitoneal incision.

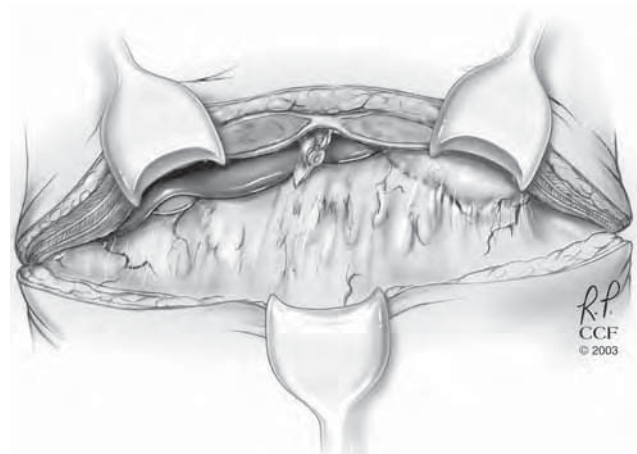


Fig. 1.20

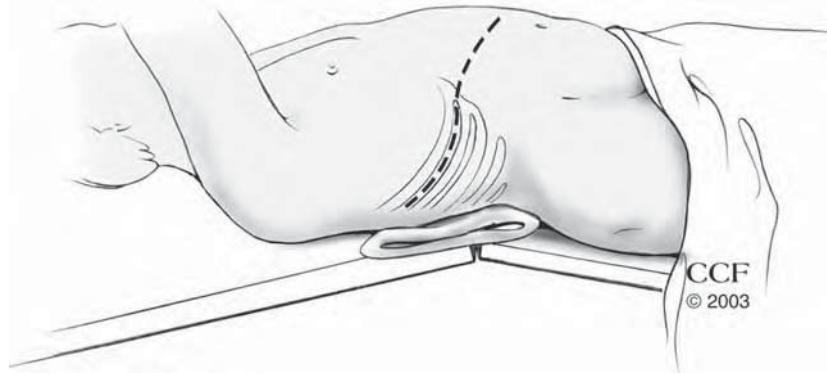


Fig. 1.21

THORACOABDOMINAL INCISION

Thoracoabdominal incision offers wide exposure of the upper abdomen, chest, and retroperitoneum for large renal, adrenal, or retroperitoneal tumors or when an ipsilateral lung nodule is to be removed concurrently.

With the patient in the semi-oblique position and the bed extended, an incision is made through the eighth or ninth intercostal space extending inferomedially to or across the midline. It may also be extended caudally along the midline if needed. The abdominal portion of the incision is opened first as described above if the finding of metastatic disease or tumor fixation is likely to terminate the operation.

The costal cartilage between the tips of the two ribs on either side of the incision is then divided with heavy scissors or rib cutters. Dissection is carried through the intercostal muscles along the upper border of the adjacent lower rib in order to avoid the neurovascular bundle.

The pleura is opened under direct visualization. The diaphragm is incised.

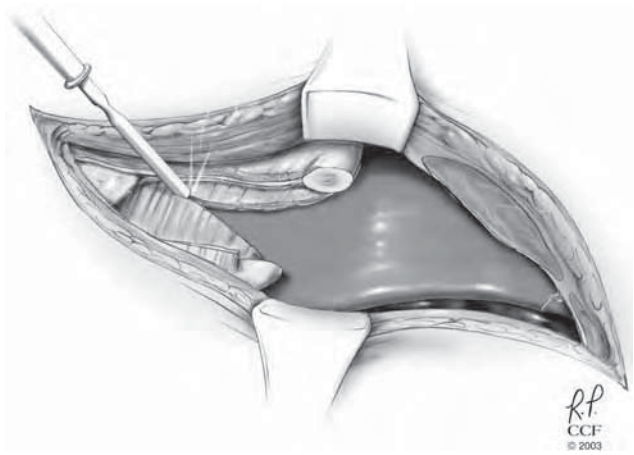


Fig. 1.23

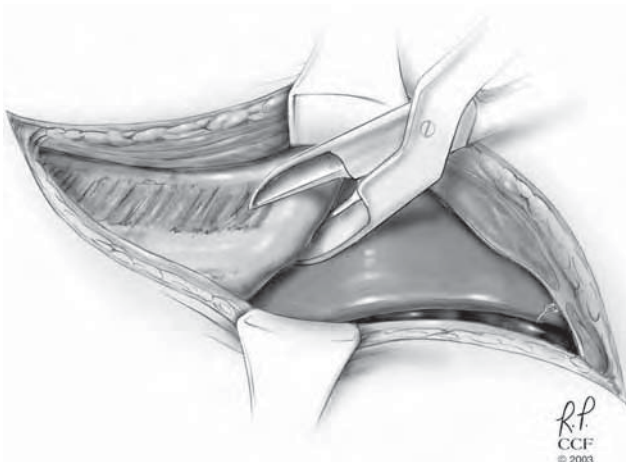


Fig. 1.22

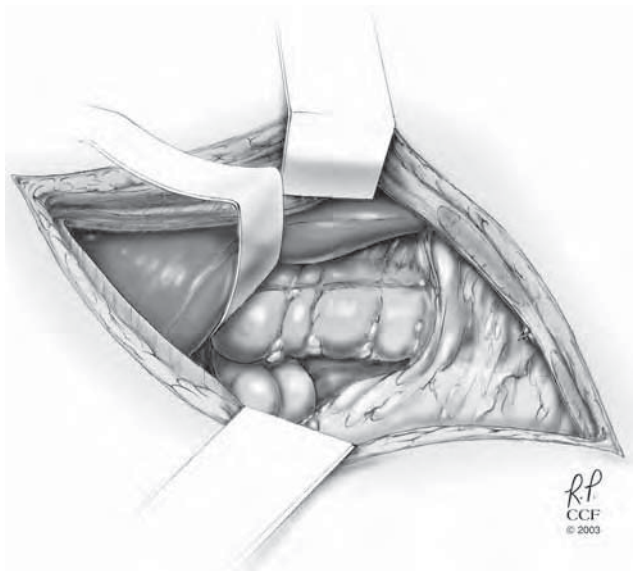


Fig. 1.24

With the diaphragm opened, the liver can be retracted into the thorax to maximize exposure of the underlying structures.

INCISIONS FOR EXPOSURE OF UPPER AND LOWER URINARY TRACT ORGANS

Twelfth Rib or Modified Flank Incision

A 12th rib incision carries less risk of pleural injury than entering through the bed of the 11th rib and can easily be extended inferiorly for operations involving the ureter. Although most patients will require two incisions to perform open nephroureterectomy, the procedure can be performed through a modified flank incision if extended inferiorly along the lateral border of the rectus muscle in thin patients, especially women. The time saved in repeat prep and draping is worth the effort in appropriate patients.

The positioning should be similar to an 11th rib incision, but the patient should be rotated slightly dorsad. The 12th

rib is marked, and the bed developed in the same manner as the 12th rib incision. The subcostal nerve is protected as in Fig. 1.12. Below the rib bed, the incision is angled downward along the lateral border of the ipsilateral rectus muscle. If required, a “hockey stick” angulation across the recti 2 cm above the pubis can be made for better bladder exposure.

Reflecting the peritoneum medially by blunt dissection gives excellent visualization of the retroperitoneum.

Midline Abdominal Incisions

The most versatile abdominal incision is the midline, as it can be extended in either direction if needed. This makes it the choice for diagnostic exploratory laparotomy or trauma.

Within the bony limits of the sternal xyphoid process above and pubis below, there is flexibility to use the portion needed. If the incision must extend beyond the umbilicus, we prefer to encircle it so the incision is not subject to moisture.

The midline is incised through the skin and subcutaneous tissue to expose the linea alba. This structure is identified by the decussating fibers between the bellies of the two recti abdomini. Although dissection laterally helps identify the linea alba, excessive mobilization can leave dead space that can lead to seroma or hematoma and subsequent wound infection. Understanding that there are two layers of the rectus fascia above the semilunar line (arcuate line of Douglas) is most important during wound closure.

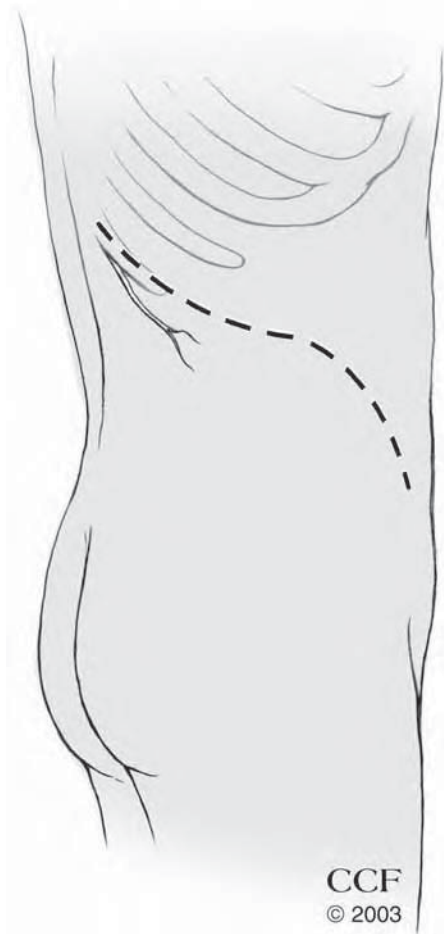


Fig. 1.25

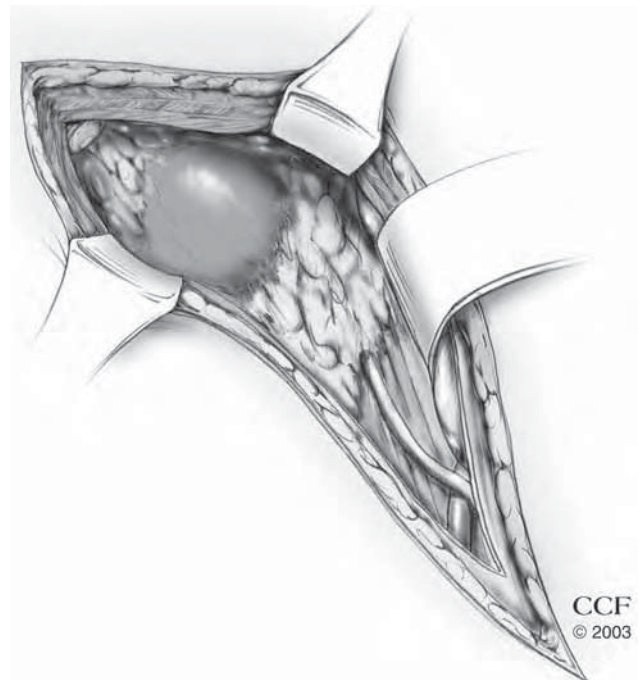


Fig. 1.26

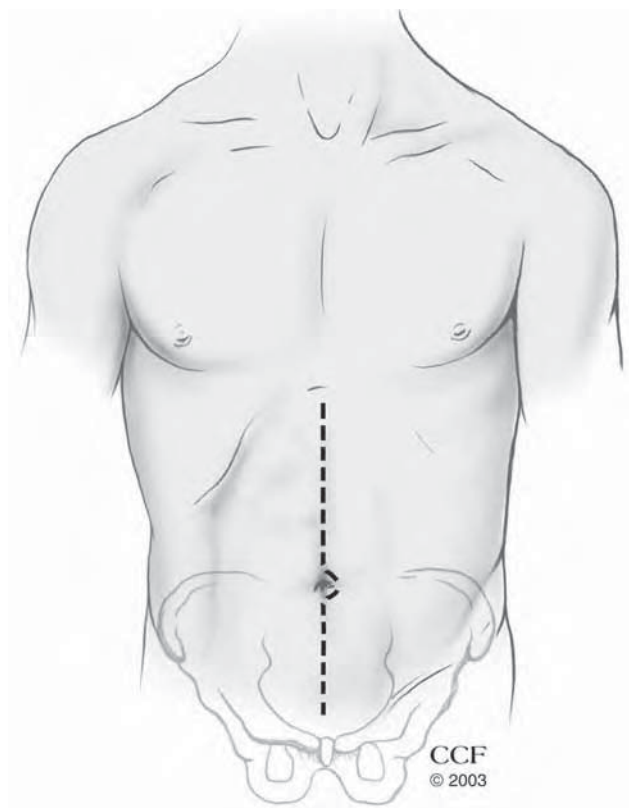


Fig. 1.27

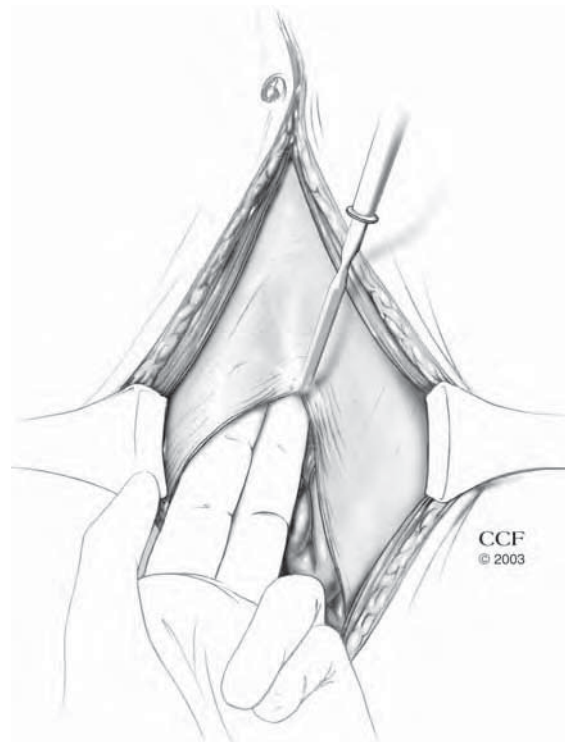


Fig. 1.29

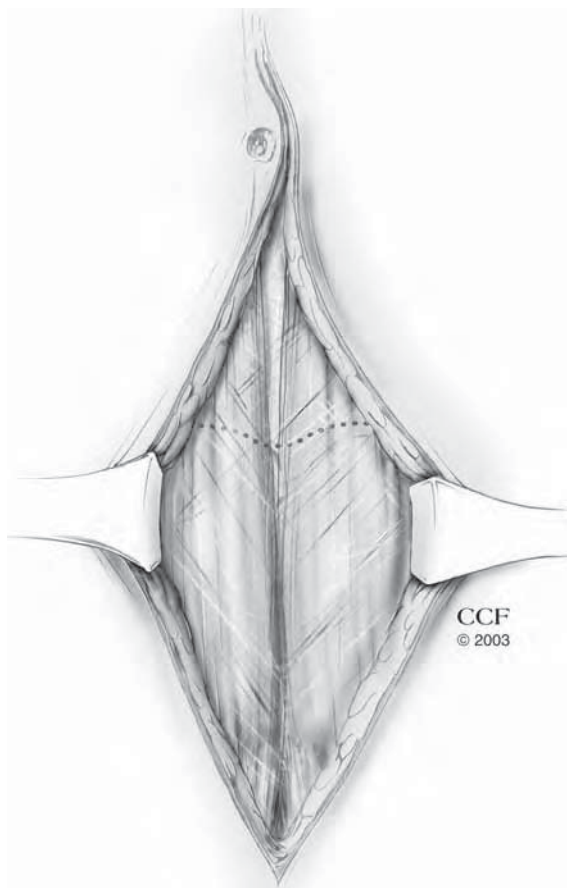


Fig. 1.28

The linea alba is wider immediately below the umbilicus than it is nearer the pubis, so it is easier to enter in this area.

Care is taken going through the linea alba, preperitoneal fat, and peritoneum to prevent inadvertent injury to underlying structures if no adhesions are present. The nondominant hand can hold up the abdominal wall for protection.

Gibson's Incision

Now used mainly for renal transplantation, the Gibson incision affords relatively atraumatic access to the iliac fossa and ureter.

In the supine position, an incision is made 2–3 cm medial to the line from the anterior superior iliac spine to the pubis. Surgeon preference will dictate whether the incision parallels that line or curves moderately. Some also prefer to make a “hockey stick” extension across the midline about 2 cm above the pubis, which gives more access to the bladder.

The external oblique aponeurosis is exposed. An incision is made along the lateral border of the rectus abdominus.

If more medial exposure is needed, the rectus may be transected across its tendinous attachment to the pubis. The inferior epigastric artery may be ligated and divided as it passes along the posterior aspect of the rectus.

The transversalis fascia is incised to expose the correct plane for blunt dissection. The peritoneum and

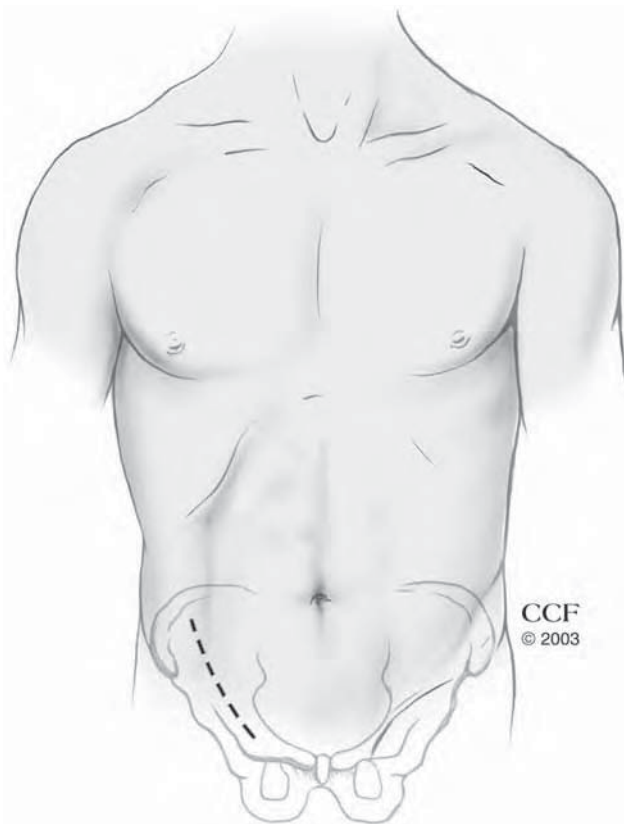


Fig. 1.30

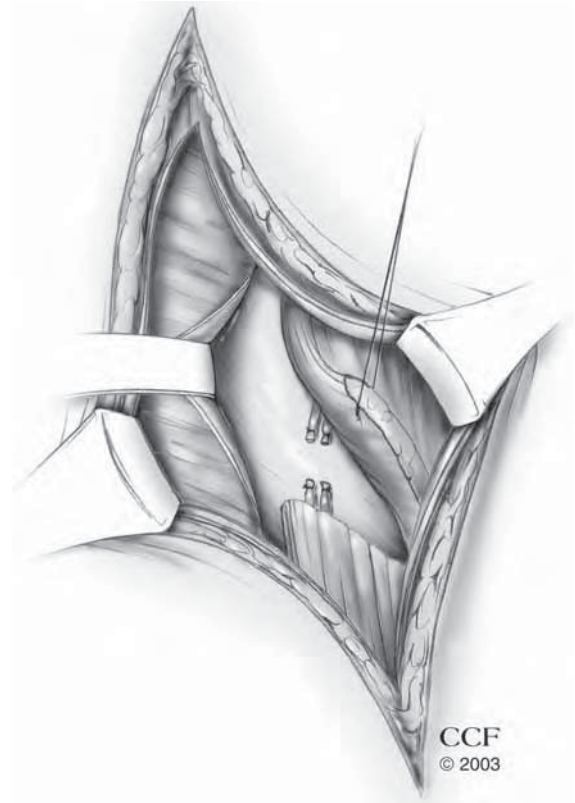


Fig. 1.32

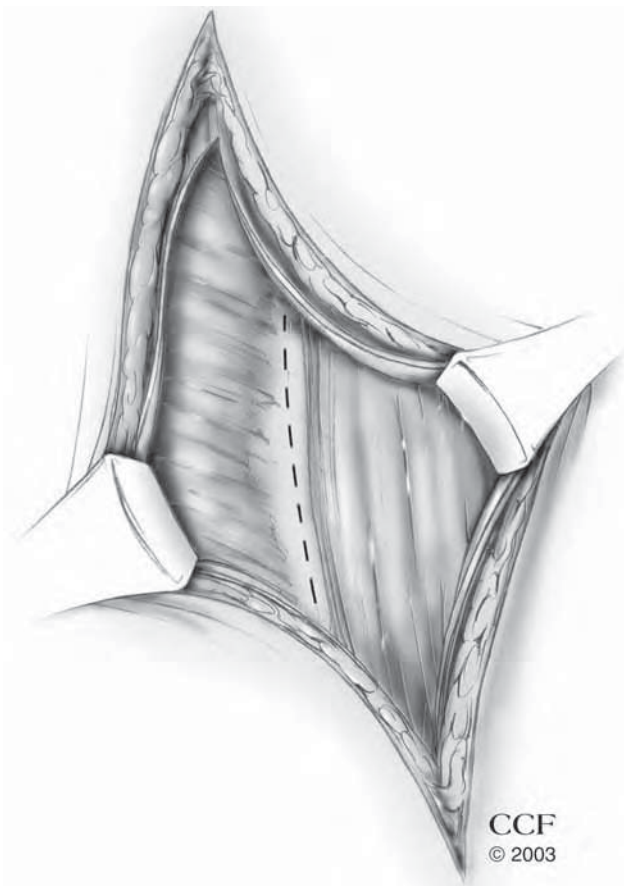


Fig. 1.31

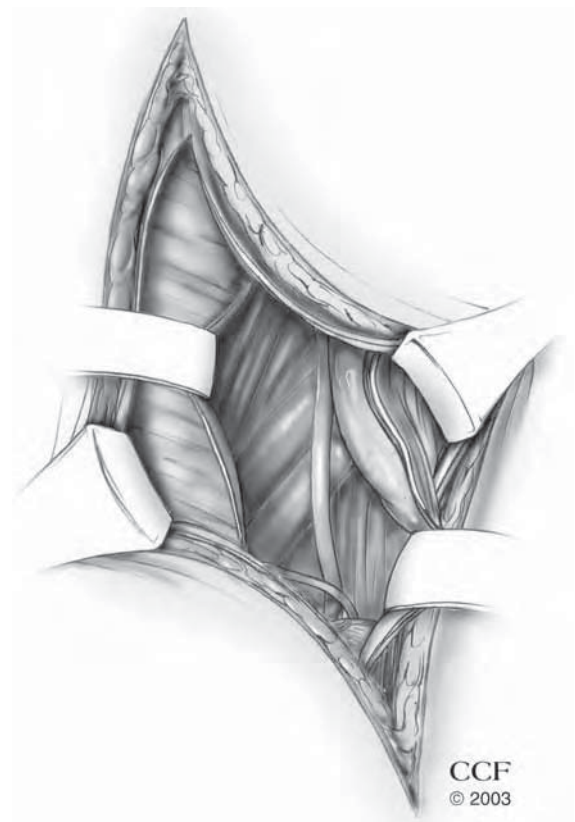


Fig. 1.33

bladder are swept medially to develop the extraperitoneal space.

INCISIONS FOR EXPOSURE OF LOWER GENITOURINARY AND PELVIC STRUCTURES

Infraumbilical Incision

Although it shares the same skin incision as an inferior midline incision, the infraumbilical incision is performed in a completely extraperitoneal manner.

The incision is begun below the umbilicus as in Fig. 1.27, but the peritoneum is not opened after incising the linea alba. It is easier to find the midline near the umbilicus because the linea alba is wider at this point.

Identifying the proper plane is often overlooked in developing the space of Retzius. The first plane encountered after opening the linea alba is superficial to the transversalis fascia. If this plane is developed, troublesome venous bleeding may be encountered and the inferior epigastric vessels may be injured. Opening the thin transversalis fascia allows the relatively avascular plane to be developed by sweeping two fingers along the posterior pubis. Gently pulling cephalad will expose the entire space of Retzius in two to three

sweeps. Body wall retraction ventrally assists in this maneuver. This plane protects the inferior epigastric vessels, which can be retracted laterally without injury.

Lower Abdominal Transverse Incision

Although several variations have been described, Pfannenstiel's incision is still the standard for exposure of the bladder and pelvis. The incision is strong and cosmetically acceptable. In most patients, it can be hidden below the pubic hairline. Although the skin incision is transverse, the Pfannenstiel actually functions as a midline incision in disguise.

The patient is positioned similarly to other lower abdominal incisions unless simultaneous vaginal incision requires lithotomy. In women, it is ideal to make the incision just below or at the hairline.

The incision is carried through the skin and subcutaneous tissues to expose the rectus fascia, which has only an anterior layer at this level below the semilunar line of Douglas. Undermining the skin superiorly allows the fascia to be opened further from the pubis if needed. The fascia is incised either sharply or with the electrocautery. Ending the fascial incision at the lateral borders of the recti limits the risks of injury to the ilioinguinal nerve and contents of the inguinal canal.

Each leaf of the divided rectus fascia is grasped approx 1 cm lateral to the midline with Allis clamps and retracted

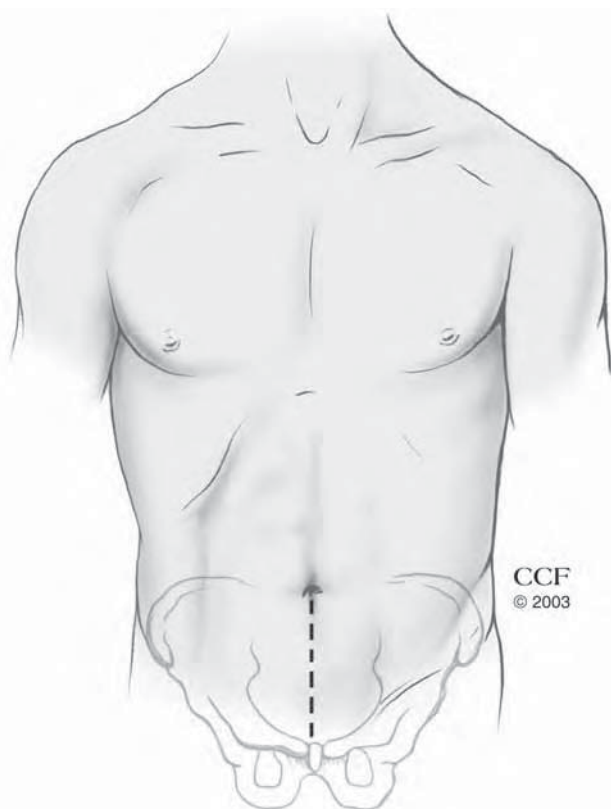


Fig. 1.34

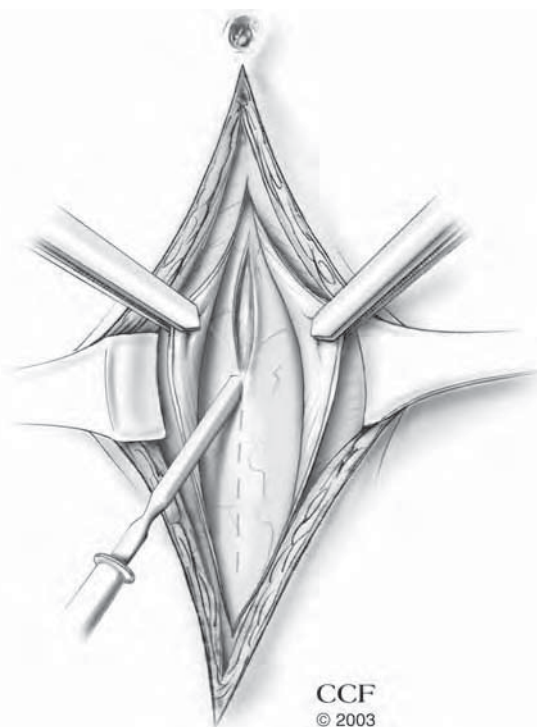


Fig. 1.35

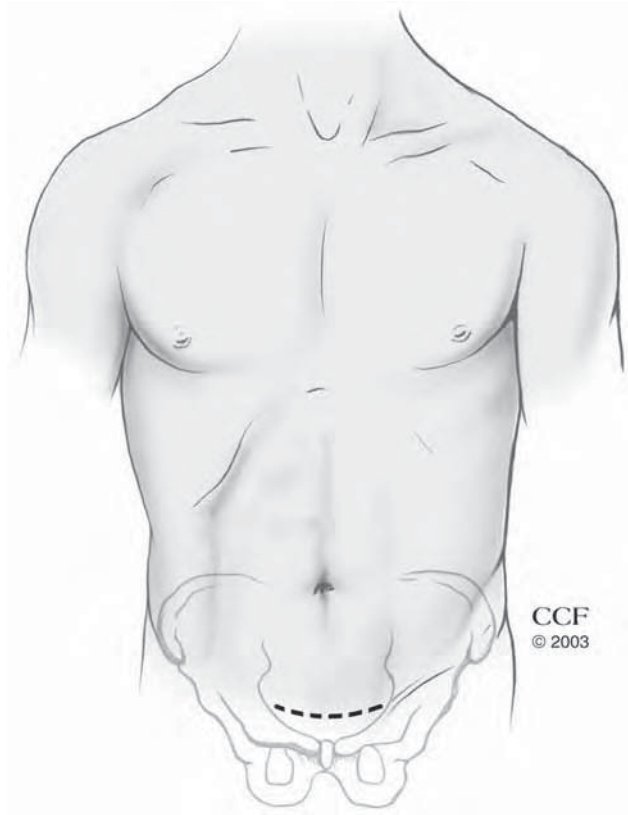


Fig. 1.36

ventrally. Countertraction is supplied by gently pushing the rectus abdominus muscle dorsally with a kuttner or sponge stick. The attaching bands can be divided under tension with the electrocautery. The limiting factor in mobilization will be the dense midline attachments. Inadequate control of penetrating vessels can lead to troublesome postoperative bleeding and possible pelvic hematoma.

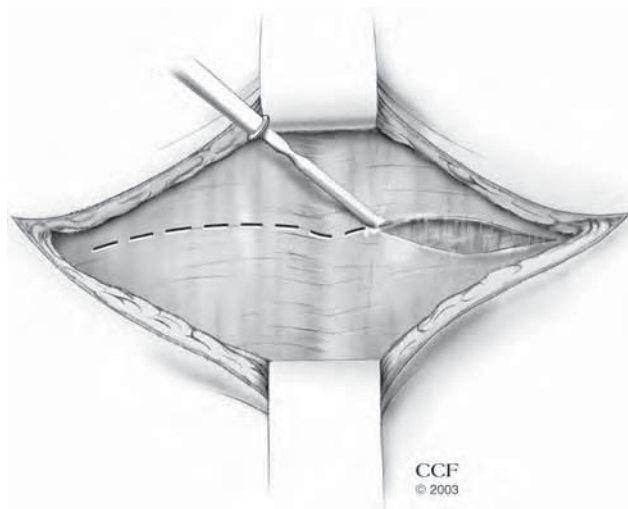


Fig. 1.37

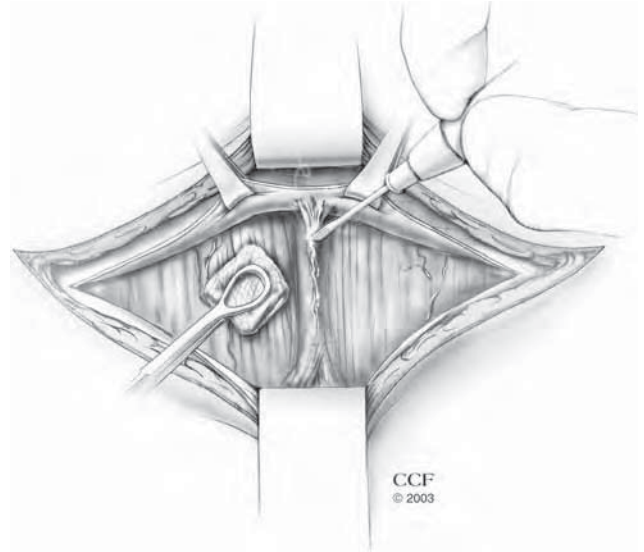


Fig. 1.38

A curved clamp bluntly separates the two recti, which are retracted laterally.

Incising the transversalis fascia, as described in Fig. 1.35, opens the proper plane of dissection. Sweeping the plane between bladder and pelvis exposes the obturator nerves and vessels.

Inguinal Incision

Perhaps the most confusing three-dimensional anatomy urologists encounter is in the inguinal canal. The spatial relationships are best learned at the operating table.

A skin incision is created 1 or 2 cm above the inguinal ligament, identified as the line between the anterior superior iliac spine and the pubic tubercle. Making the incision

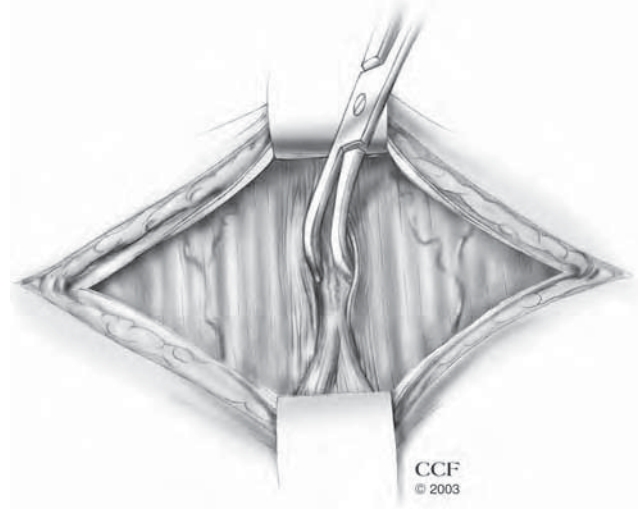


Fig. 1.39

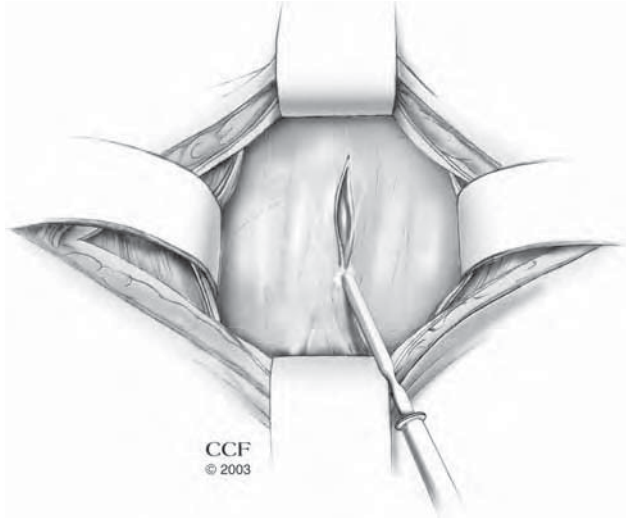


Fig. 1.40

above the inguinal (Poupart's) ligament helps avoid moisture from the groin crease.

Scarpa's (and occasionally Camper's) fascia is visualized as the dissection is carried to the external oblique aponeurosis. Care must be taken to identify and control the superficial epigastric branch of the saphenous vein. It is helpful to fully define the lower aspect of the external

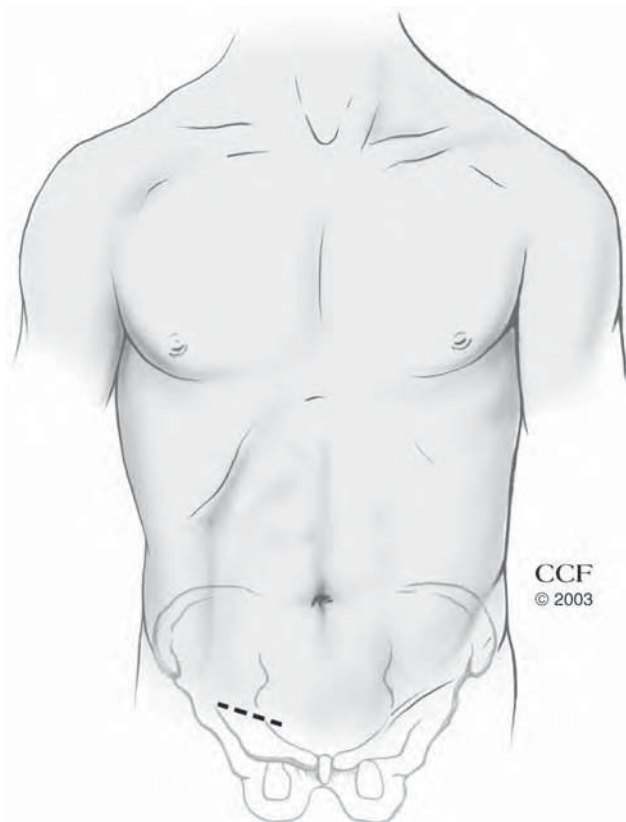


Fig. 1.41

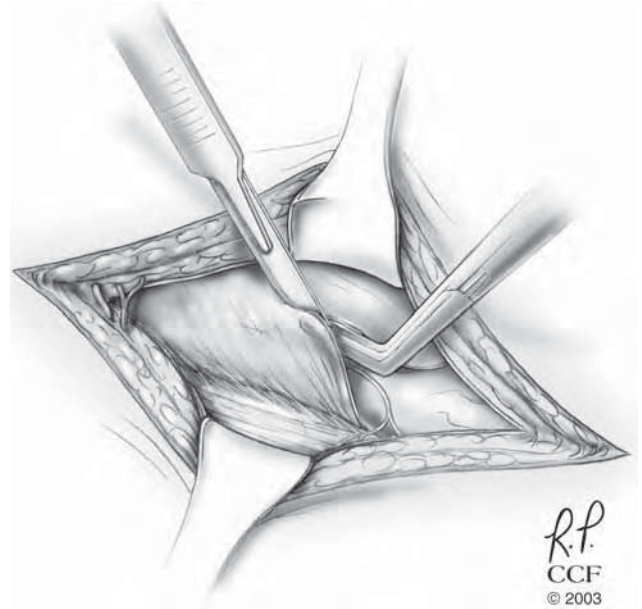


Fig. 1.42

oblique aponeurosis, where it rolls inward to form the inguinal ligament. Just above the pubic tubercle, the aponeurosis separates around the spermatic cord to form the external inguinal ring.

Gentle traction on the ipsilateral testis facilitates identification of the cord. A right-angled clamp is placed through the external ring to hold the decussating fibers of the aponeurosis away from the cord. These fibers are divided sharply with a scalpel, protecting the underlying ilioinguinal nerve. Alternatively, a no. 15 scalpel blade can be used to incise the external oblique in the direction of its fibers 1.0 cm above and parallel to the inguinal ligament. Taking care to protect the underlying nerve, the spermatic cord is mobilized bluntly. The shelving edge of the inguinal ligament is identified beneath this.

2

Adrenal Disease

Open Surgery

Andrew C. Novick

SURGICAL ANATOMY

The adrenal glands are paired structures located medial to the upper poles of each kidney. The average adult adrenal weighs 3–8 g and has a characteristic shiny yellow appearance that differentiates it from the surrounding adipose tissue and pancreas. The two glands are not identical, differing with respect to size, shape, and exact location. The left adrenal is elongated and flat, whereas the right is triangular, slightly smaller, and located more superiorly than the left. The adrenals are enveloped in a compartment of Gerota's fascia and are surrounded by an adipose and connective tissue covering that forms a pseudocapsule, facilitating surgical dissection.

The arterial blood supply to the adrenal glands is multiple and variable, whereas the venous drainage is constant (Fig. 2.1). On the left side, the gland is supplied superiorly by arteries arising from the inferior phrenic artery. Along its medial aspect, branches of the middle adrenal artery originating directly from the aorta enter the gland after passing through the periaortic lymph nodes and celiac ganglia. The inferior adrenal artery arises near the origin of the left renal artery, either superiorly from the aorta or directly from the proximal left renal artery. Therefore, great care should be used when dissecting near the origin of the left renal artery to avoid transecting this branch. The venous drainage of the left adrenal gland is almost exclusively via the inferior adrenal vein, which enters the cephalic aspect of the left renal vein. This entry site occurs near the lateral margin of the aorta, which can serve as a useful landmark when dissecting the left renal vein to gain initial exposure of the adrenal vein.

As on the left side, the right adrenal gland derives its blood supply superiorly from the inferior phrenic artery. Medially, multiple middle adrenal arteries arising from the aorta course beneath the vena cava and through the pericaval lymphatics to enter the gland. The inferior adrenal

artery has a relatively constant origin from the proximal portion of the right renal artery.

Some important anatomical differences pertaining to the vasculature of the right adrenal gland should be noted. First, the superior adrenal arteries on the right side lie at a higher level than on the left, even though the kidney is usually lower. This, and the presence of the overlying liver and the vena cava medially, can make the dissection of the right superior adrenal arteries more difficult than the left. Second, the drainage of the right adrenal is by a single adrenal vein, shorter and more friable than the left, entering directly into the vena cava just below the hepatic veins. This vein usually is located higher and is shorter than one might expect, and it is usually necessary to dissect surrounding tissue to gain appropriate exposure before ligating this vein.

The left adrenal gland is more elongated and situated lower on the superomedial aspect of the kidney than the right, placing it close to the renal hilum and left renal pedicle. Therefore, great care must be taken in the surgical exposure of the inferior surface of the left adrenal so as not to traumatize the left renal artery or vein. The stomach, pancreas, spleen, and splenic vessels are contiguous with the anterior surface of the left adrenal gland, while the upper pole of the kidney lies lateral and the diaphragm and pleural reflection posterosuperiorly (Fig. 2.2).

The right adrenal gland lies more cephalad than the left and is close to the liver superiorly. The kidney is lateral, the duodenum is anterior, and the diaphragmatic and pleural reflections are posterior to the gland (Fig. 2.3). Often, the medial portion of the right adrenal is retrocaval, and the adrenal vein commonly enters the posterolateral vena cava. Dense attachment of the gland to the posterior surface of the vena cava in combination with a short and friable adrenal vein makes meticulous dissection and adequate exposure a requirement to prevent troublesome hemorrhage when performing right adrenalectomy.

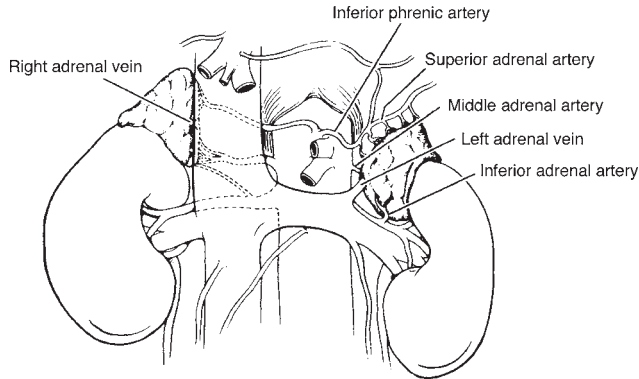


Fig. 2.1

Normal adrenal blood supply.

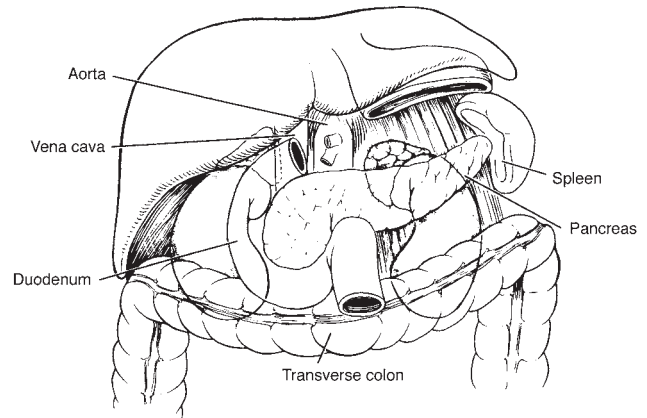


Fig. 2.3

Anatomical and surgical relationships of the adrenal glands viewed through an anterior abdominal approach.

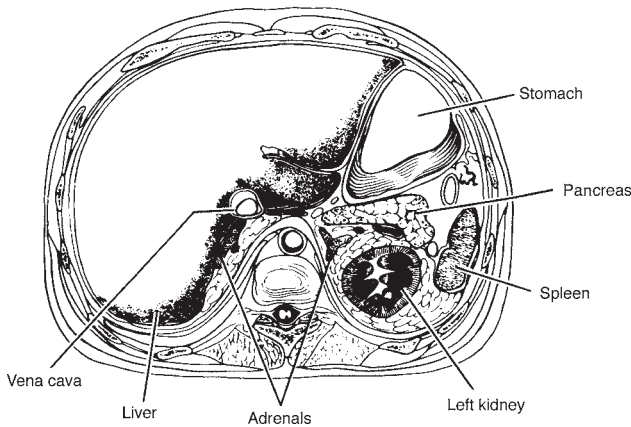


Fig. 2.2

Anatomical relationships of the adrenal glands, as depicted by computed tomography (CT) scan at the T1a level.

OPERATIVE APPROACHES

There is a wide spectrum of adrenal pathology that requires surgical intervention (1). One or both adrenal glands may need to be removed for either benign or malignant tumors. Adrenal hyperplasia or hormonally active adrenal tumors can be an indication for surgery.

A variety of operative approaches are available for adrenal surgery. The optimal technique must be individualized for each patient according to the adrenal pathology, the patient's body habitus and surgical history, and the familiarity of the surgeon with each operative approach (2-4).

In recent years, laparoscopic adrenalectomy has become the treatment of choice for benign adrenal disorders such as (1) primary aldosteronism, (2) Cushing's disease or Cushing's syndrome caused by an adrenal adenoma (5), (3) small benign pheochromocytomas, or (4) other benign lesions such as a cyst or myelolipoma (4). Other indications have included small nonfunctioning adrenal masses with radiographic features suspicious for malignancy and small

solitary adrenal metastases. Open surgical adrenalectomy, the focus of this chapter, is primarily indicated in patients with large pheochromocytomas (6) or clinical overt adrenal cortical carcinomas (7). These operations are generally performed through an anterior transabdominal approach or through a thoracoabdominal approach (2,3).

Anterior Transabdominal Approach

The anterior transabdominal approach is indicated for adrenal lesions that are either large or potentially malignant. These include suspected or proven adrenal cortical carcinomas and large adrenal pheochromocytomas. In these cases, wide exposure is necessary, which cannot be achieved to the same extent through an extraperitoneal incision. With potentially malignant adrenal masses, intra-abdominal inspection of other organs for metastatic disease is required. An anterior approach is also mandatory for adrenal malignancies that involve the inferior vena cava. The optimal anterior approach is through a bilateral subcostal or chevron incision, which provides much better exposure of the superior and lateral aspects of the adrenal gland than a midline incision. A unilateral extended subcostal incision can be used if the patient is thin and only one adrenal gland needs to be exposed. A vertical midline incision is used only if an extra-adrenal pheochromocytoma is suspected in the retroperitoneum along the great vessels or in the pelvis.

The main advantage of the transabdominal approach is that it provides excellent exposure of both adrenal glands, the vascular pedicles, the abdominal organs, and the retroperitoneum. Its principal disadvantage is that the peritoneal cavity is entered. It is not the most direct avenue to the adrenal glands, and in an obese patient exposure may be more difficult.

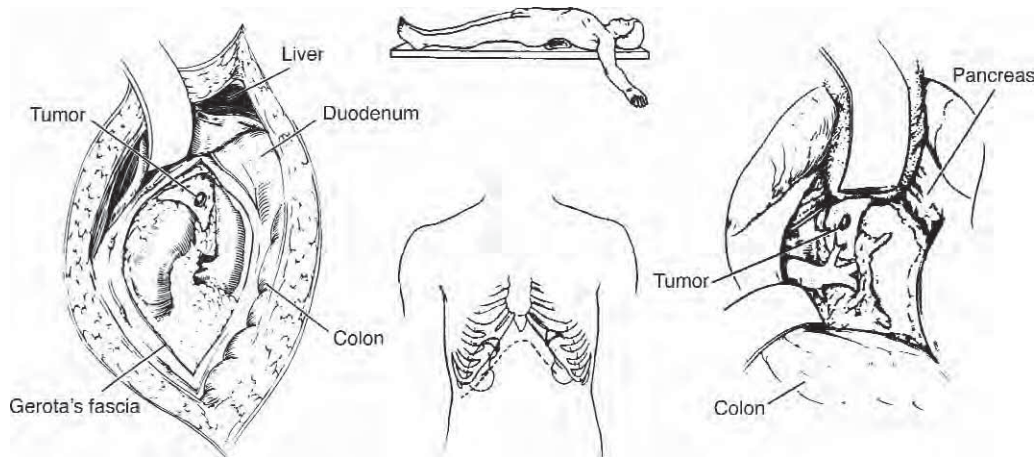


Fig. 2.4

Anterior transabdominal approach to the adrenal glands.

The patient is placed with a rolled sheet beneath the lumbar spine, and a unilateral extended subcostal or bilateral subcostal incision is made to enter the peritoneal cavity (Fig. 2.4). On the right side, the posterior peritoneum lateral to the ascending colon is incised, the colon and the duodenum are reflected medially, and the liver is retracted superiorly to expose the kidney and adrenal gland. The kidney is gently retracted downward to bring the anterior surface of the right adrenal gland into view. In most cases it is necessary to release the upper margin of the gland from the liver with sharp dissection to obtain complete exposure. In cases of pheochromocytoma, it is important to secure the adrenal vein as soon as possible to interrupt catecholamine release from the tumor into the systemic circulation. If the vein lies far cephalad, as it often does, division of the arterial supply medially and inferiorly may be necessary before the vein can be exposed satisfactorily and safely. Surgical exposure is facilitated by medial retraction of the inferior vena cava. In cases of suspected malignancy, it is also best to isolate the medial blood supply first and to carry out the lateral dissection later. For tumors confined to the adrenal gland, after the blood supply has been secured, the remaining lateral and inferior attachments of the gland are mobilized and divided to complete the adrenalectomy.

On the left side, the adrenal gland is exposed by incising the posterior peritoneum lateral to the descending colon and dividing the ileorenal ligament with medial retraction of the colon and superior retraction of the spleen. The left adrenal vein is identified at its entry into the left renal vein and is then ligated and divided. The inferior adrenal artery also is secured and divided at this time. The adrenal gland is mobilized posteriorly and laterally by blunt dissection. The gland is then retracted

downward to expose the superior vascular attachments, which are secured and divided. The gland is then retracted laterally to expose the remaining medial arterial blood supply, which is secured and divided. Residual attachments of the gland to the upper pole of the kidney are divided into sharp dissection to complete the adrenalectomy.

In some cases an adrenal malignancy may invade the upper pole of the kidney. In this event, radical *en bloc* removal of both the kidney and adrenal gland within Gerota's fascia is the indicated procedure (Fig. 2.5). The main renal artery and vein are secured and divided in sequence, as in a radical nephrectomy; the ureter also is secured and divided. A plane is then developed posteriorly along the psoas muscle, bluntly mobilizing both the kidney and adrenal mass from behind and laterally. With downward and lateral retraction of the kidney, the medial blood supply to the tumor mass can be better identified. This exposure is facilitated by medial retraction of the vena cava. The medial adrenal arteries are secured and transected. On the right side, as the dissection proceeds upward, the adrenal vein also is identified, secured, and divided. This vein is large and friable, often lies higher than the surgeon expects, and must be carefully dissected free from surrounding structures to prevent avulsion from the vena cava. Should such an avulsion occur, the caval entry is immediately secured with Allis clamps and the defect is oversewn with a continuous 5-0 arterial suture. After the blood supply is secured, the dissection is carried upward and laterally to completely remove the tumor mass and kidney *en bloc* with Gerota's fascia. A regional lymphadenectomy is then performed from the level of the inferior mesenteric artery to the crus of the diaphragm. Splanchnic nerves and celiac ganglia may be sacrificed if adjacent nodes appear involved by neoplasm.

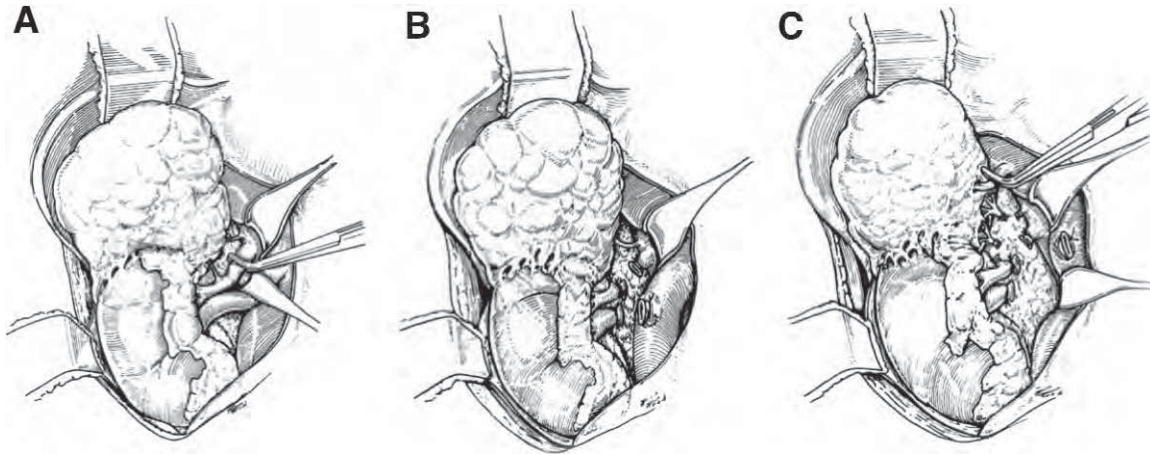


Fig. 2.5

Technique of radical nephroadrenalectomy on the right side.

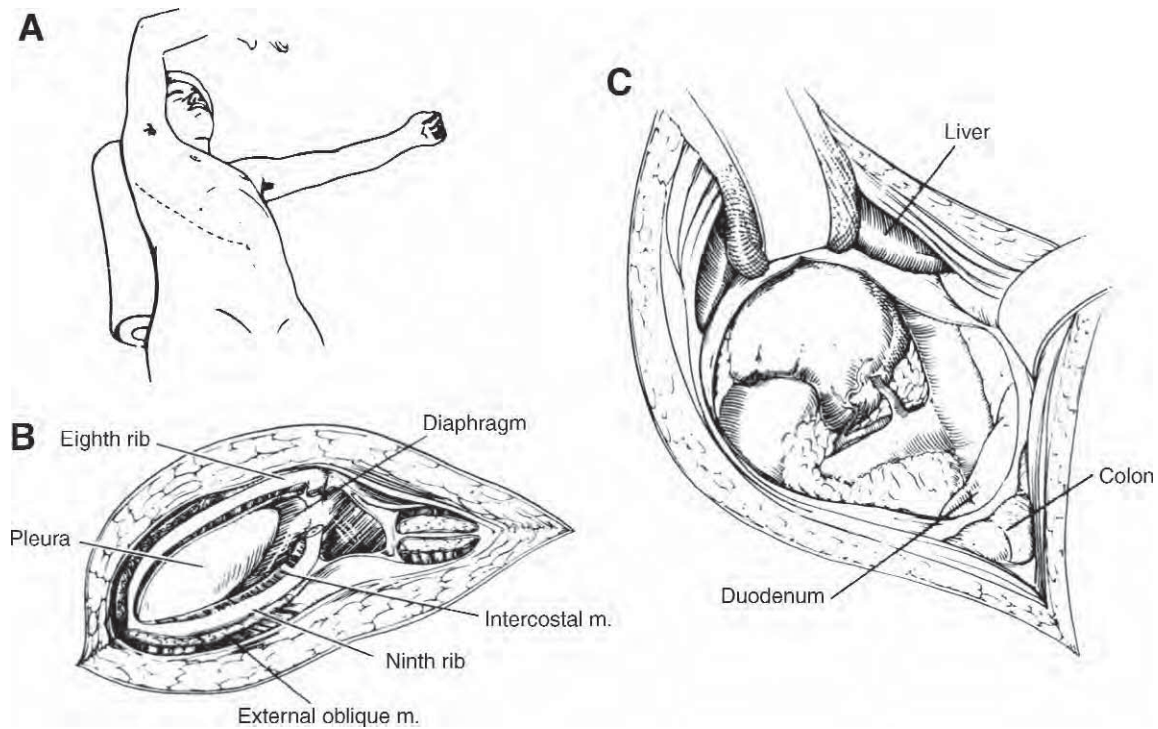


Fig. 2.6

Thoracoabdominal approach to the adrenal gland.

Thoracoabdominal Approach

The thoracoabdominal approach to the adrenal gland is desirable for very large tumors that cannot be removed safely through an anterior transabdominal incision. It can be particularly advantageous for large right-sided adrenal masses, where the overlying liver and vena cava can limit exposure. There is less indication for this incision on the left side because the spleen and the pancreas usually can be elevated away from the adrenal without difficulty. The thoracoabdominal incision provides excellent exposure of

the suprarenal area; however, additional operative time is required to open and close a thoracoabdominal incision. Because the thoracic cavity is entered and the diaphragm divided, potential pulmonary morbidity is greater. For these reasons, the thoracoabdominal approach is reserved for patients in whom exposure beyond that provided by an anterior subcostal incision is considered important for complete and safe tumor removal.

The patient is placed in a semi-oblique position with a rolled sheet inserted longitudinally between the flank and hemithorax (Fig. 2.6). The incision is begun in the eighth or