

# THORACOABDOMINAL RADICAL NEPHRECTOMY: SPLENIC AND LIVER INJURY

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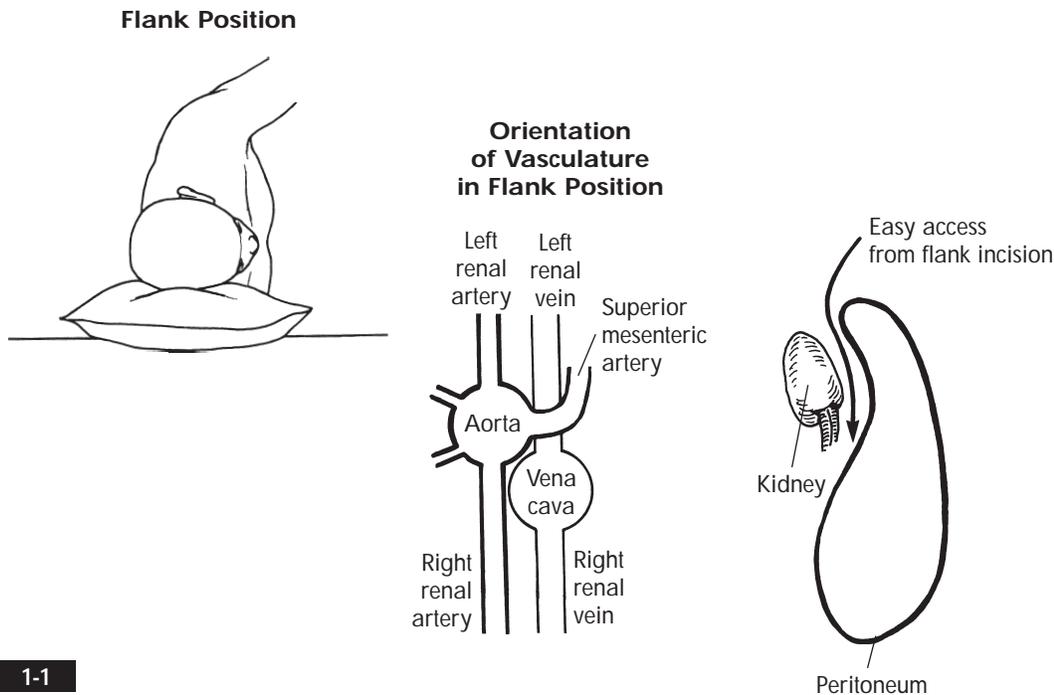
## LATERAL POSITION AND FLANK INCISION

FIG. 1-1. The lateral positioning of the flank incision provides the easiest access to the kidney in the retroperitoneum. However, if a large left hilar or upper pole renal mass exists, the surgeon may find that the orientation of the midline vasculature is obscured when the patient is in the lateral position.

Although the superior mesenteric artery lies superior to the re-

nal vein and the renal artery lies posterior and inferior to the renal vein, there have been reports of experienced surgeons ligating and dividing the superior mesenteric artery, mistaking it for the left renal artery, during a left radical nephrectomy.<sup>1,2</sup>

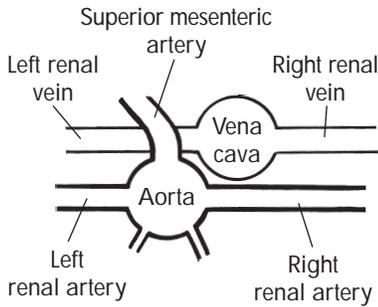
In addition to the confusion of vascular orientation in large renal tumors, dissection of the renal hilum for good vascular control is difficult.



**Supine Position**



**Orientation of Vasculature in Supine Position**



1-2

**SUPINE POSITION AND MIDLINE INCISION**

FIG. 1-2. The supine position with a midline incision provides good exposure and orientation of the midline great vessels and major branches. However, if the incision is not carried up to the xiphoid process or higher, resection of large medial or superior pole renal masses may be difficult.

With the patient in a supine position, the superior pole of the kidney is angled posteriorly, and therefore resection of a large superior renal mass is difficult.

FIG. 1-3. The best compromise is to have the chest and upper abdomen positioned at a 45-degree angle from the operating table and the lower abdomen placed as flat as possible in a supine position—a torque configuration. A long sandbag behind the back maintains this position. The best positioning is achieved when the break of the table is in line with the anterior superior iliac spine.

The 45-degree-angled position provides easy access to the upper pole of the kidney and retroperitoneum, yet the near-supine position of the lower abdomen affords good orientation and allows optimal control of the midline vasculature.

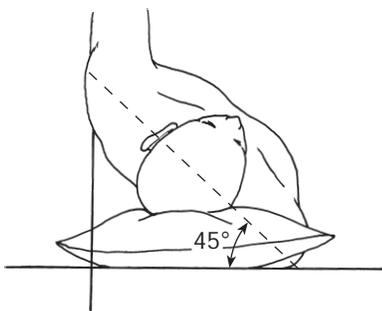
Specifically, for large left-sided tumors, a more exaggerated medial reflection of the left colon and transverse colon helps the surgeon to identify the superior mesenteric artery from the renal pedicle. The surgeon frees the posterior parietal peritoneum along the line of Toldt from the sigmoid colon all the way around the splenocolic ligament and part of the transverse colon.

**CHEVRON INCISION AND SUBCOSTAL WITH EXTENDED-T INCISION**

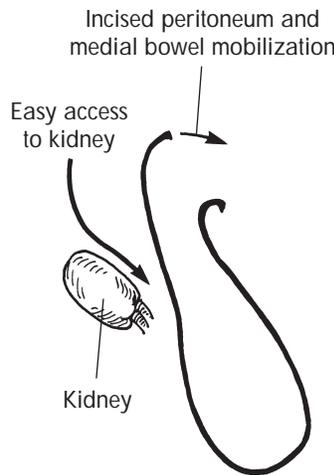
FIGS. 1-4 AND 1-5. Whether using a thoracoabdominal, chevron, or subcostal with an extended-T incision, the surgeon attains good access to the high retroperitoneum by the following maneuver. The principal objectives of patient positioning involve the following:

- 1 45-degree angle of the chest and upper abdomen
- 2 As much supine position as possible in the lower abdomen
- 3 Flexion of the table at the anatomic landmark of the anterior superior iliac spine

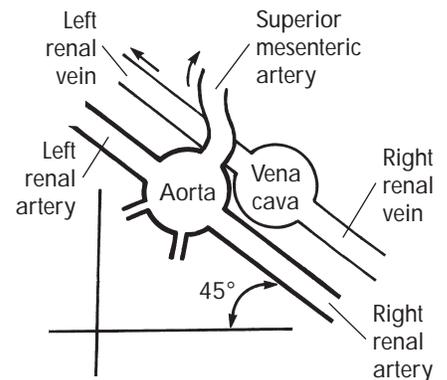
**45-Degree Position**

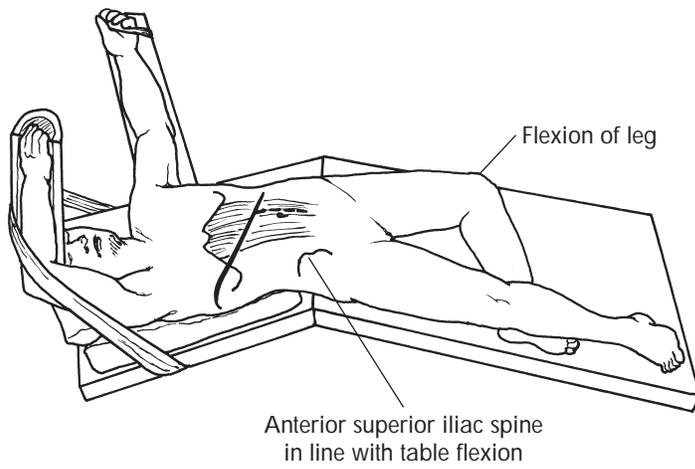
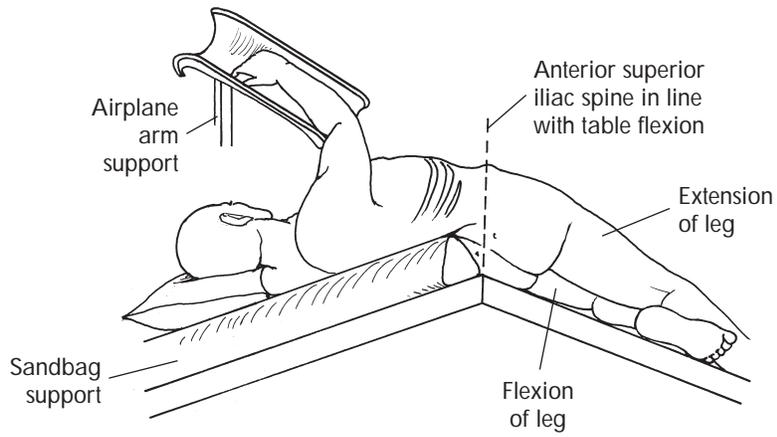


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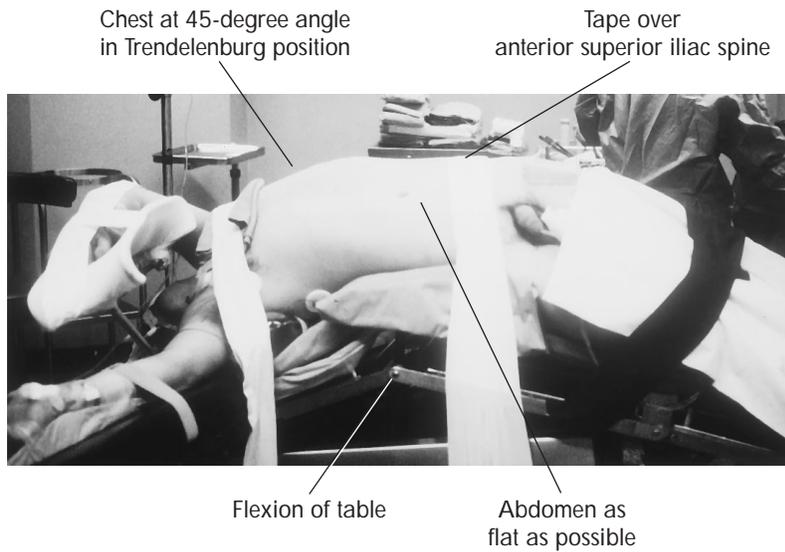


**Orientation of Vasculature in 45-Degree Position**



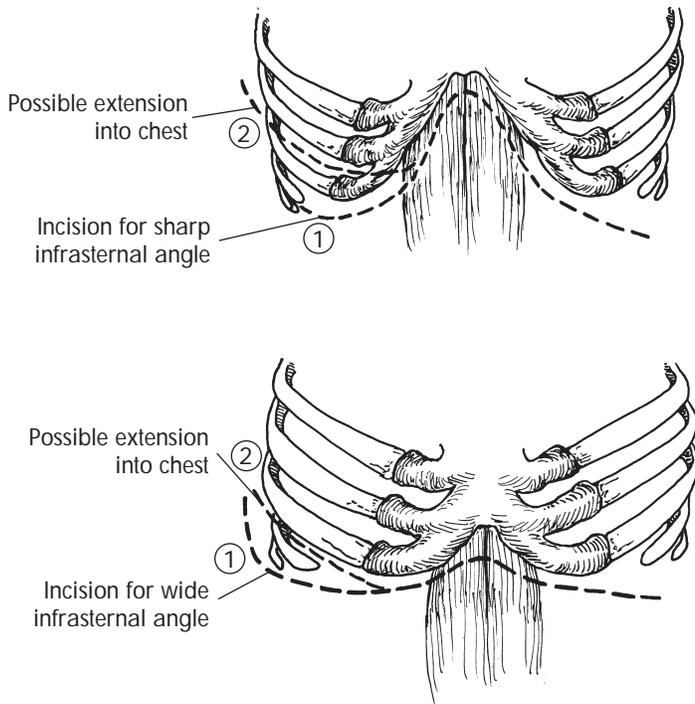


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**Chevron Incision**



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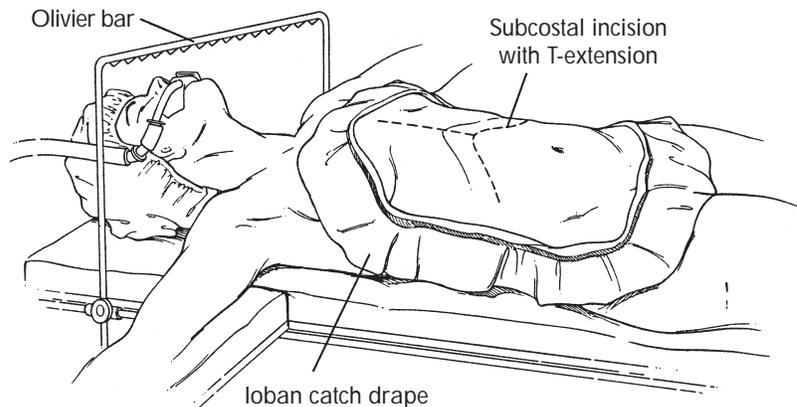
FIGS. 1-6 AND 1-7. If a chevron or subcostal with an extended-T incision is chosen,<sup>3</sup> the surgeon should ensure that the incision extends laterally past both rectus abdominis muscles and superiorly to the xiphoid process. Especially in patients with sharply angled costal margins, this extension superiorly allows good exposure of the vena cava and of the aorta and its major branches. The surgeon should be prepared to extend these incisions into the pleural cavity if needed (2).

**THORACOABDOMINAL INCISION**

The thoracoabdominal incision provides the best exposure for high retroperitoneal dissections. This incision is especially suited for right-sided hilar or upper renal tumors associated with a large liver.

FIGS. 1-8 AND 1-9. Beginning at the eighth or ninth rib interspace, the surgeon makes an incision from the posterior axillary line all the way across the cartilage and past both rectus abdominis muscles in a straight diagonal line. This incision not only provides excellent exposure but also contains the bowel mobilized medially. We

**Subcostal with Extended-T Incision**



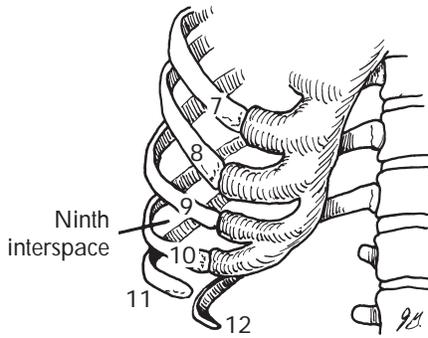
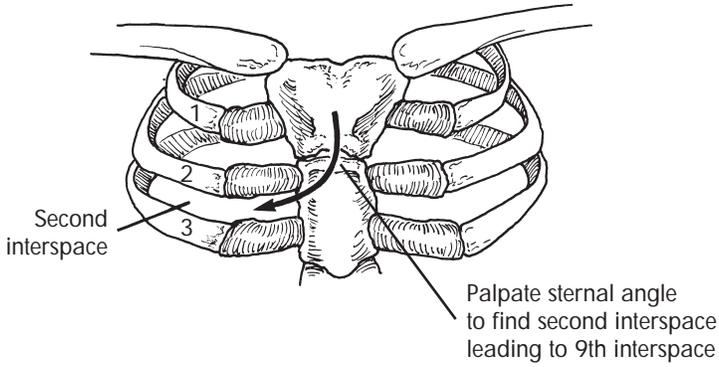
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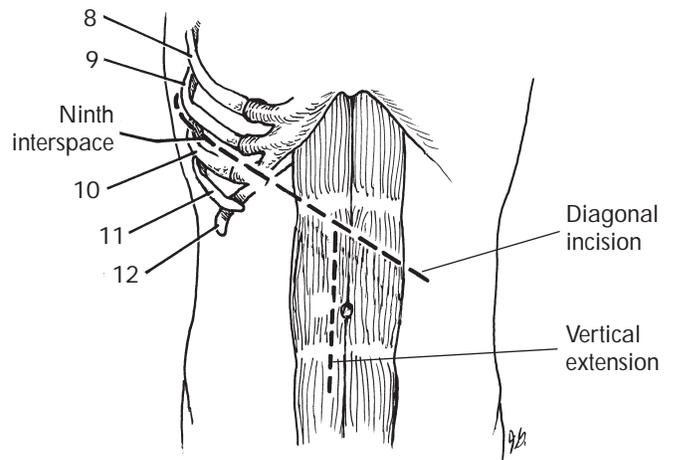
have not found the combination of a diagonal incision and a vertical extension to be helpful.

FIG. 1-10. After the peritoneum is opened, the pleural cavity is

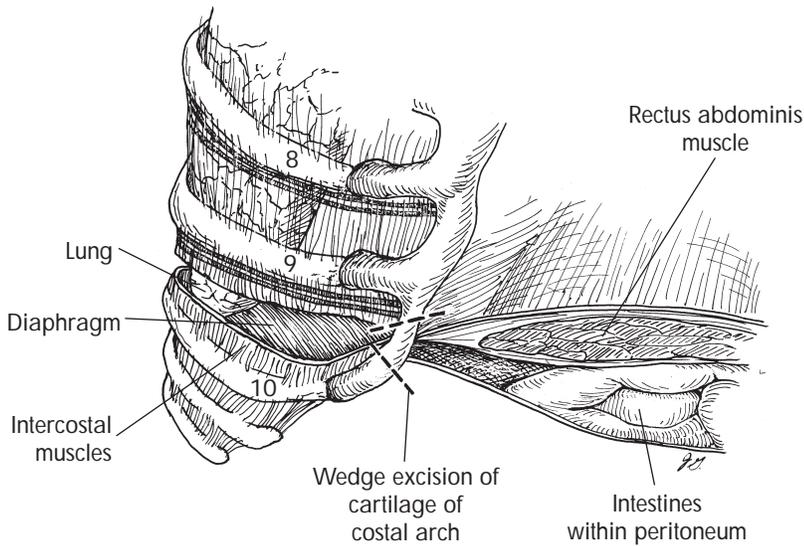
opened through the eighth or ninth intercostal space and the surgeon resects a segment of the costal cartilage arch to connect the peritoneum and pleural cavity.



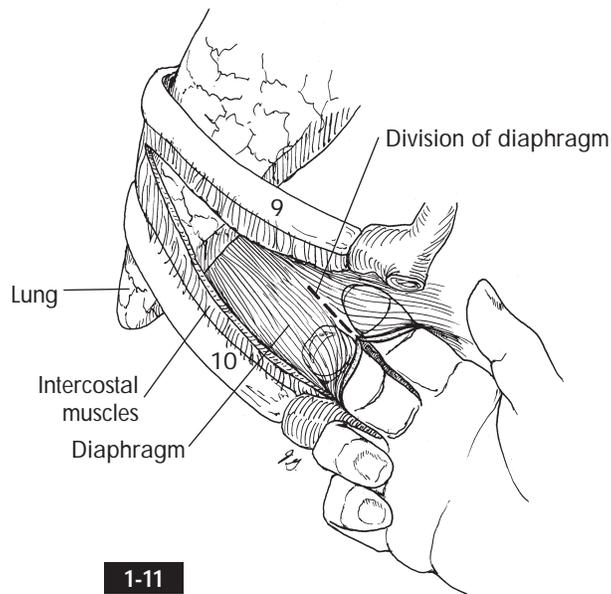
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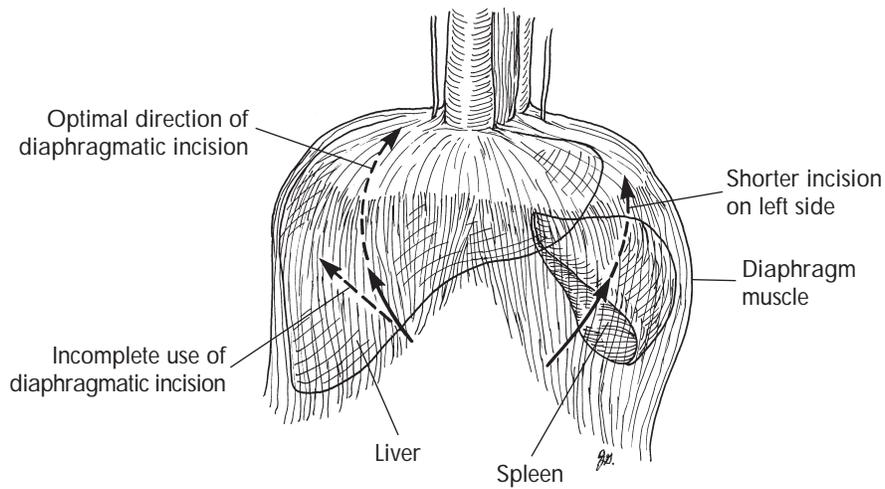
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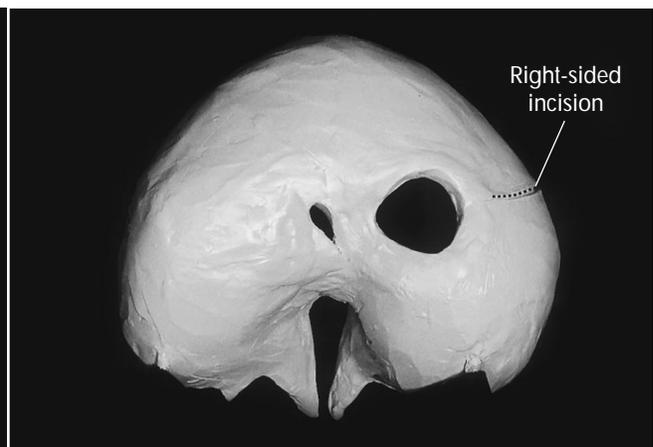
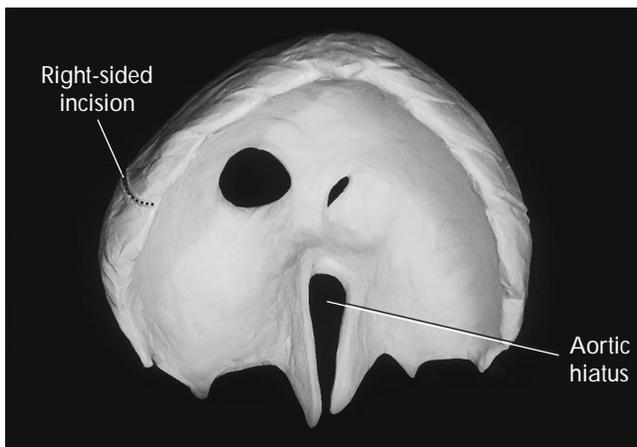
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View From Below Diaphragm Muscle

View From Above Diaphragm Muscle

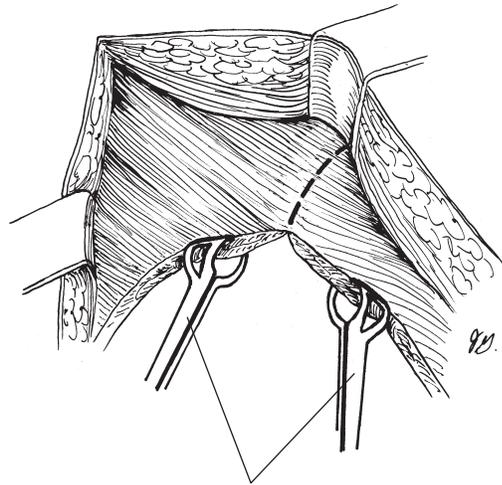


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FIGS. 1-11, 1-12, AND 1-13. The most common error in dividing the diaphragm is to cut too laterally. The surgeon's goal is to split the diaphragm such that the liver and spleen can be mobilized partially or entirely into the pleural cavity when the patient is in the Trendelenburg position.

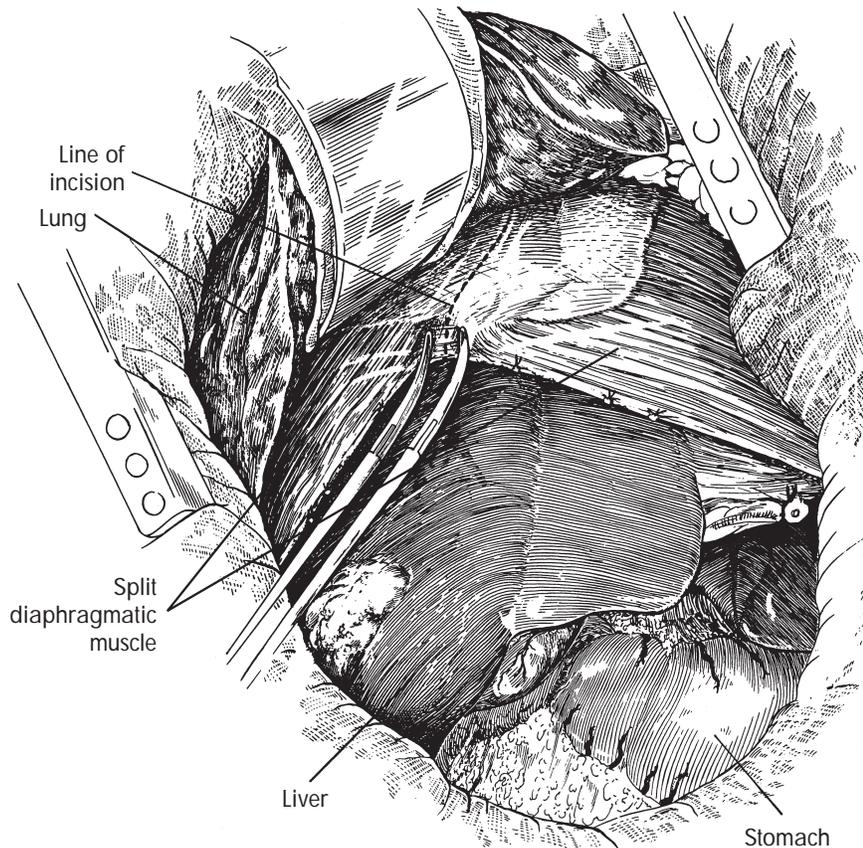
The diaphragmatic incision should be a semicircle aiming toward the great vessels and the crus of the diaphragm.

FIGS. 1-14 AND 1-15. Using Babcock clamps for traction, the surgeon should divide only one third of the total incision first and then finish the division after the Finochetto retractor is positioned between the ribs to provide a better exposure.



Diaphragm on traction for division

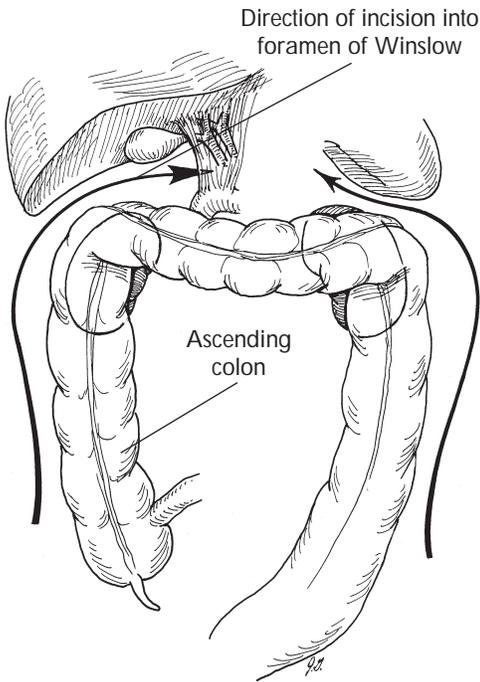
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From Zollinger RM Jr, Zollinger RM: *Atlas of surgical operations*, ed 6, New York, 1989, Macmillan.

1-15

**RIGHT RENAL CANCER**



1-16

FIG. 1-16. Immediately after completing one third of the diaphragmatic incision, the surgeon divides the parietal peritoneum along the avascular line of Toldt lateral to the ascending colon.

The incision should be carried from around the cecum to the foramen of Winslow. The incision from the hepatic flexure to the foramen should be made only after the Finochetto retractor has been positioned.

If the surgeon places two dry laparotomy pads against the ribs, the Finochetto retractor will not slip when the wound is further opened.

The Finochetto retractor is first partially opened.

The surgeon completes the diaphragmatic incision, aiming toward the great vessels and avoiding major branches of the phrenic nerve within the central tendon.

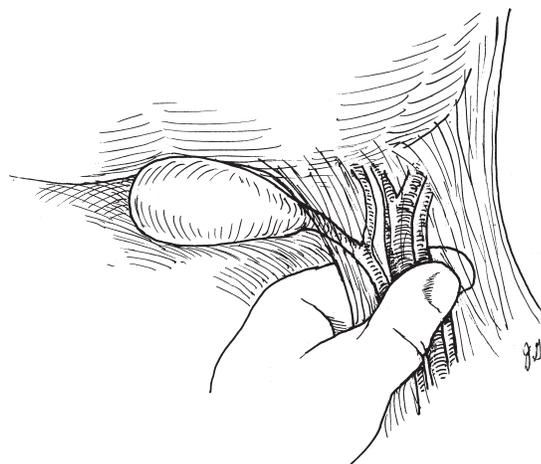
The incision from the hepatic flexure along the lateral colonic wall should be continued above

the transverse colon and behind the porta hepatis at the foramen of Winslow. This parietal peritoneal incision allows maximal bowel mobilization and reflection.<sup>4,5</sup>

FIGS. 1-17 AND 1-18. In cases of accidental liver hemorrhage from lacerations, the Pringle maneuver is useful to reduce bleeding.<sup>6-8</sup> The surgeon places the left index finger into the foramen of Winslow and compresses the tissues anterior to it with the thumb, essentially obstructing the bile duct, portal vein, and hepatic artery (portal triad). This same maneuver can be done with vascular clamps.

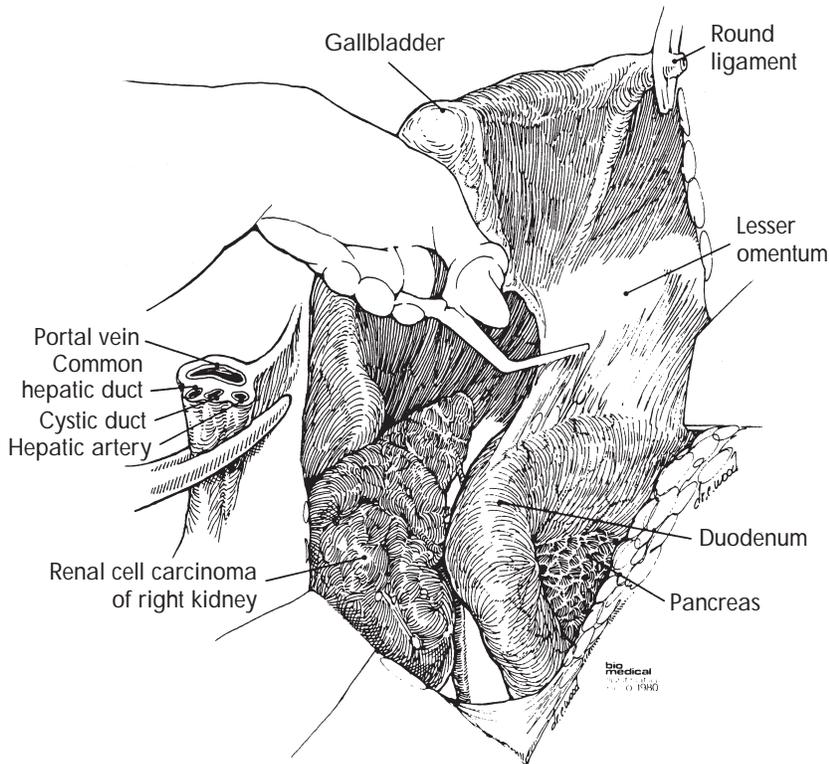
FIG. 1-19. Before reflecting the colon medially, the surgeon should first take down the three ligaments of the liver: the falciform ligaments in the midline (1), the right triangular ligament off the back muscles and diaphragm (2), and part of the left triangular ligament (3). In rare situations a part of the right coronary ligament (4) also needs to be divided.

**Pringle Maneuver:  
Compression of Porta Hepatis**



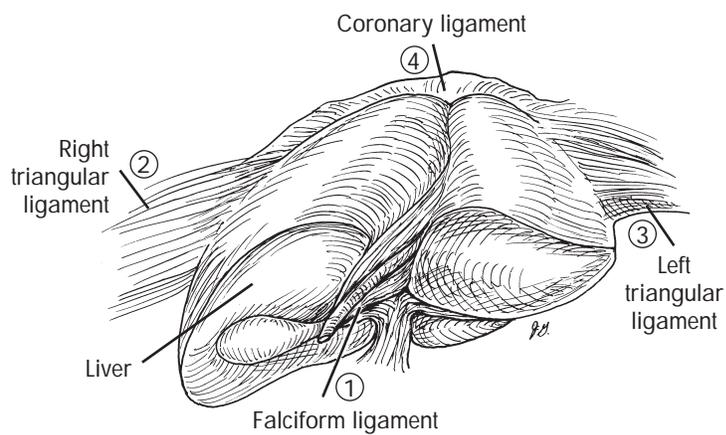
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**Cross-Clamping of Porta Hepatis**

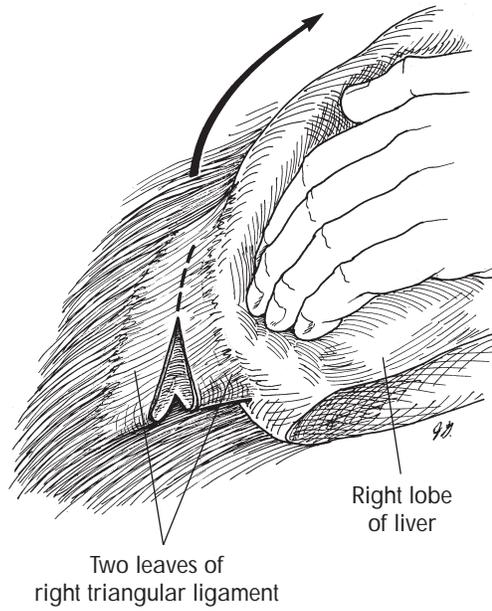


From Crawford ED, Borden TA, editors: *Genitourinary cancer surgery*, Philadelphia, 1982, Lea & Febiger.

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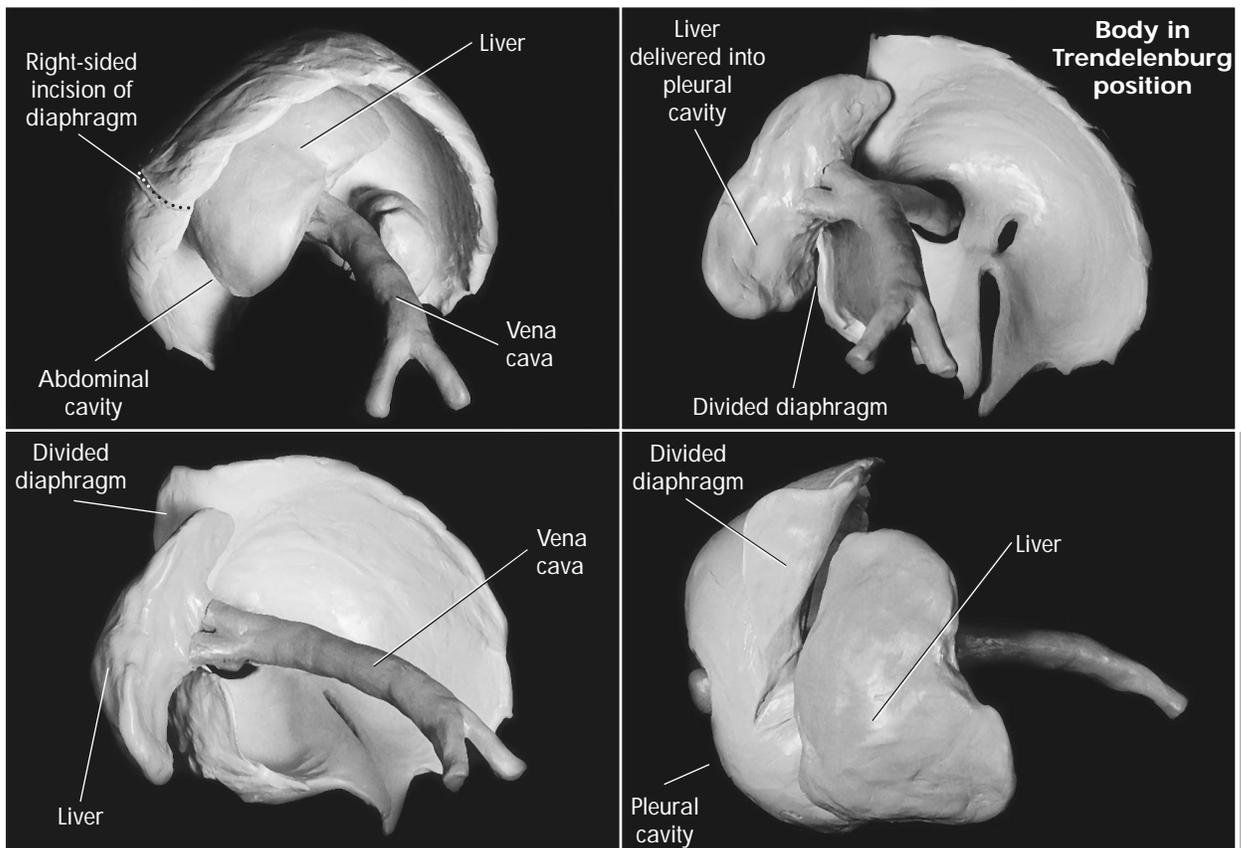


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FIG. 1-20. The division of the right triangular ligament with its two leaves may need to extend toward the coronary ligament if the right lobe of the liver is large.

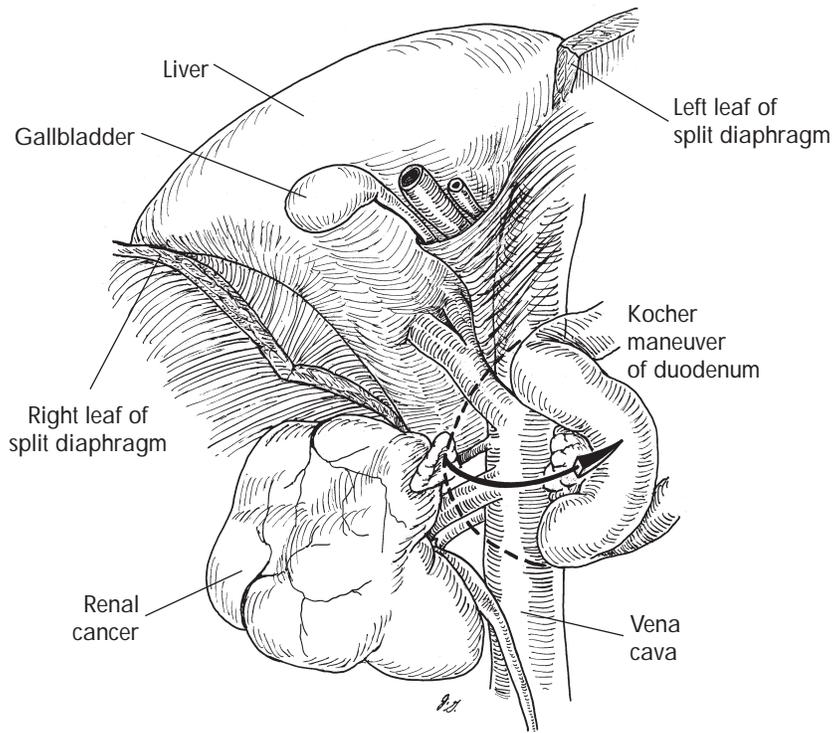
FIG. 1-21. Once these three liver ligaments are free and with the Finocchetto retractor completely opened, the patient is placed in the Trendelenburg position. The liver can now be delivered and mobilized into the pleural cavity.

FIGS. 1-22 AND 1-23. Depending on the liver configuration, the surgeon should be able to mobilize part if not most of the liver into the chest. This maneuver provides the best exposure of the high retroperitoneal region on the right side.



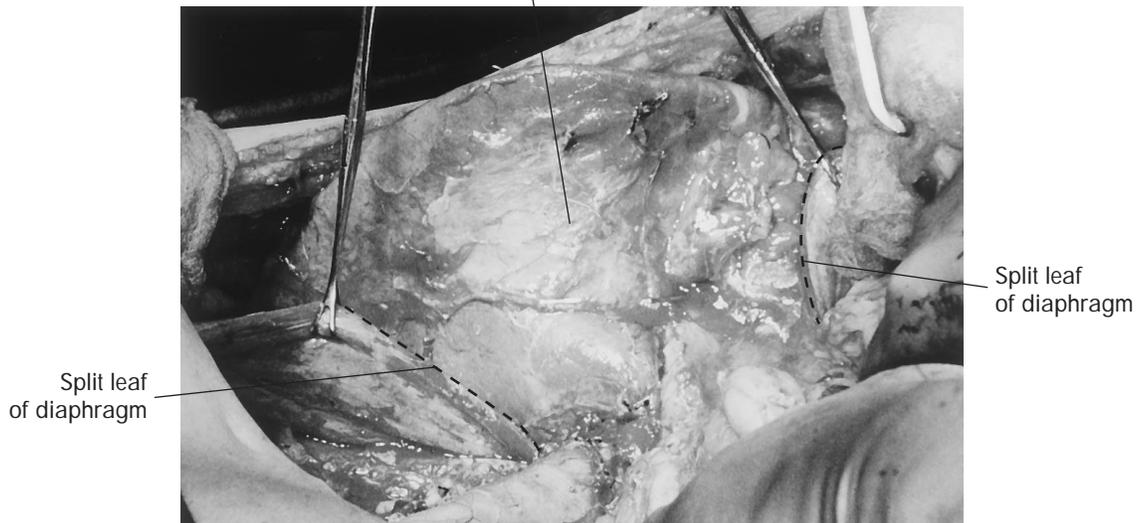
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**Liver Mobilized into Pleural Cavity  
with Patient in Trendelenburg Position**

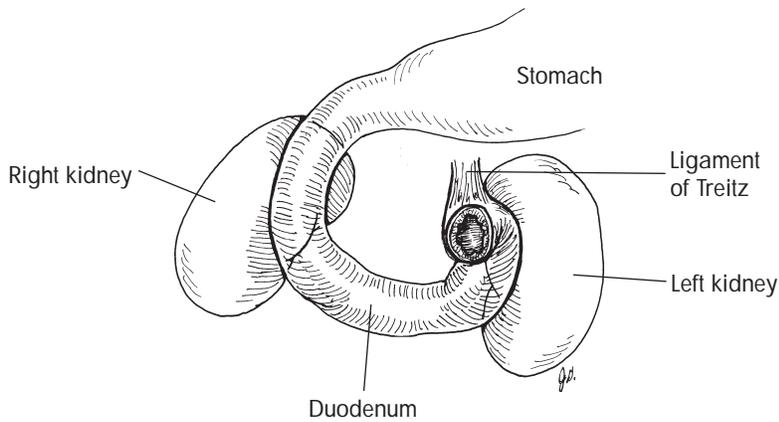


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Liver within pleural cavity

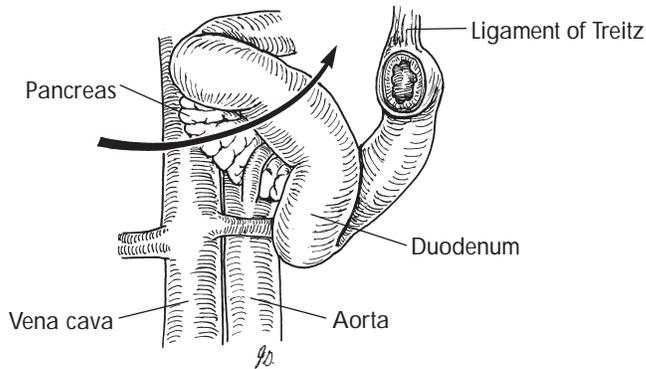


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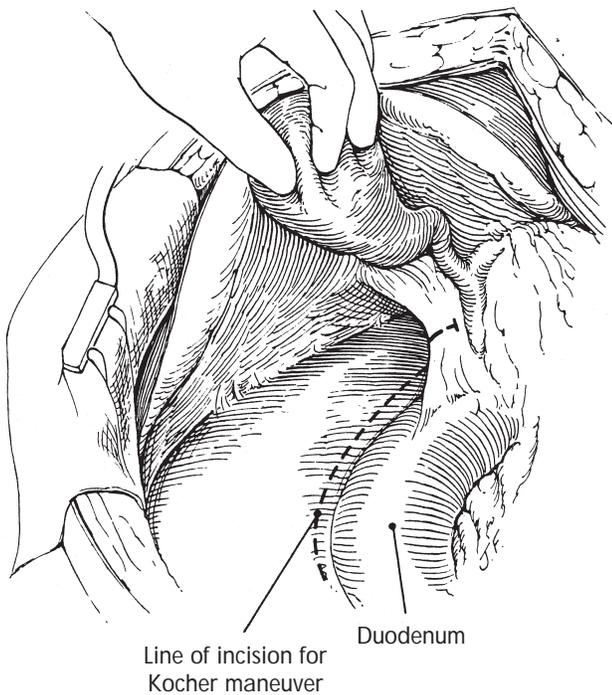


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**Kocher Maneuver**



1-25



From Crawford ED, Borden TA, editors: *Genitourinary cancer surgery*, Philadelphia, 1982, Lea & Febiger.

1-26

FIGS. 1-24, 1-25, AND 1-26. The surgeon should perform a standard Kocher maneuver of the duodenum, reflecting the duodenum medially, thus exposing the renal pedicle and part of the vena cava.

FIG. 1-27. The vena cava at the renal pedicle has three important branches:

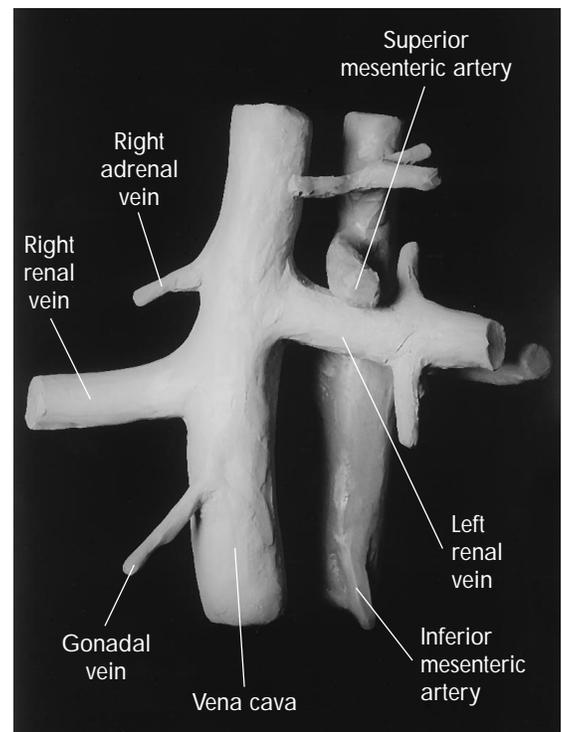
- 1 Renal vein
- 2 Gonadal vein inferiorly
- 3 Adrenal vein superiorly

Of the three, the most troublesome for potential bleeding is the adrenal vein. A torn adrenal vein is the most common bleeding site in right radical nephrectomy.

FIG. 1-28. The adrenal vein can be of a large caliber (A), can have a short segment to the vena cava (B), can be in the retrocaval position (C), or can be in a high position relative to the renal vein (D).

Even if there is easy access for isolation of the renal artery and vein, the surgeon should take ev-

**Frontal View**



1-27

ery opportunity to control and divide the adrenal vein as soon as possible.

If the renal artery is identified and isolated, the surgeon should ligate it (using 0 silk) as soon as possible to decrease the size of the renal mass immediately.

Even though the venous system is exposed more easily than the arterial system, the surgeon should *never* ligate the renal vein first. The kidney can literally expand and rupture its precarious neovasculature. The order of ligation should be (1) renal artery, (2) renal vein, and then (3) ureter.

**TUMOR THROMBUS**

FIG. 1-29. Montie<sup>9</sup> has classified tumor thrombus based on the extent of intracaval involvement:

Level I: tumor thrombus extends less than 2 cm from the renal ostia

Level II: tumor thrombus extends greater than 2 cm from the renal ostia yet remains below the hepatic veins

Level III: tumor thrombus involves the hepatic veins but does not extend to the diaphragm

Level IV: tumor thrombus is supradiaphragmatic or atrial

The majority of cases of tumor thrombus with renal vein and

vena cava involvement (greater than 60%) are at the renal and infrahepatic levels (levels I and II). This discussion is limited to these more common situations and recommends the current best operative references for intrahepatic, suprahepatic, and atrial tumor involvement; with venovenous bypass without heparinization; and with cardiopulmonary bypass with hypothermia.<sup>6, 10-12</sup>

**Extraction of Tumor Thrombus from Renal Vein and Vena Cava**

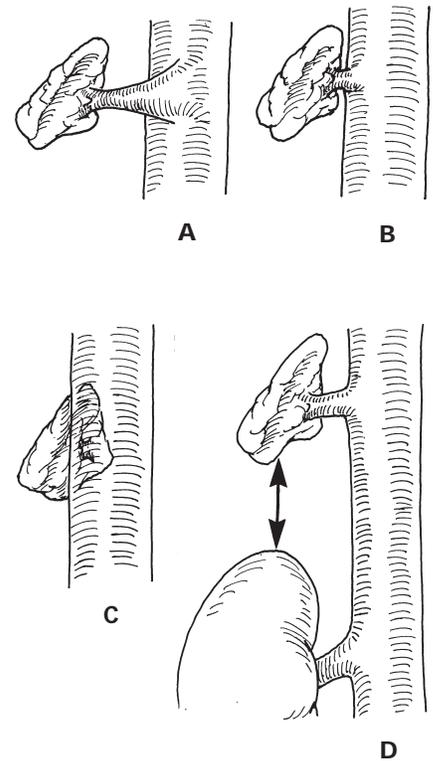
Most thrombi of renal carcinoma do not invade the wall of the renal vein or the vena cava and therefore can be removed without resection of the vascular walls.

Controlling the vena cava proximally and distally to the renal veins with Rummel vascular tourniquets or vessel loops without occluding the vessel is an invaluable safety measure in case of sudden hemorrhage.

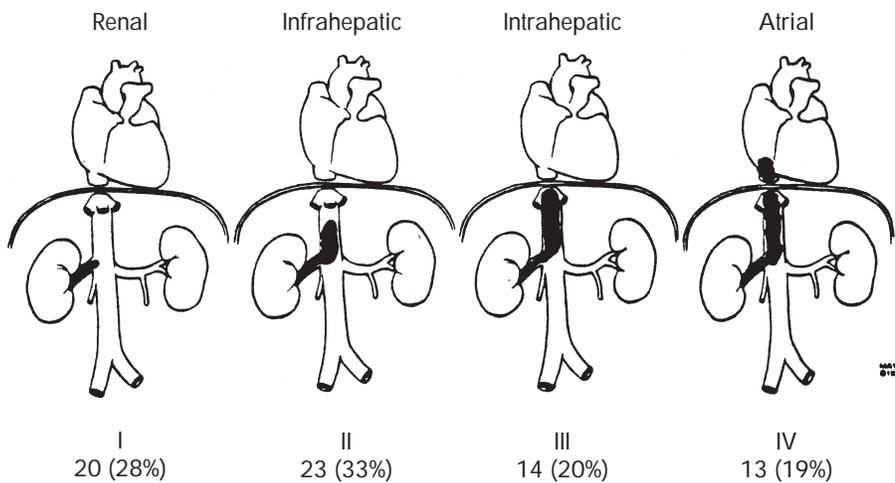
FIG. 1-30. The Satinsky clamp or its equivalent is placed around the junction of the vena cava and the renal vein.

The renal vein incision should leave a proximal cuff intact with the vena cava. The tumor thrombus is gently teased out.

**Variations of Adrenal Vein and Adrenal Gland**



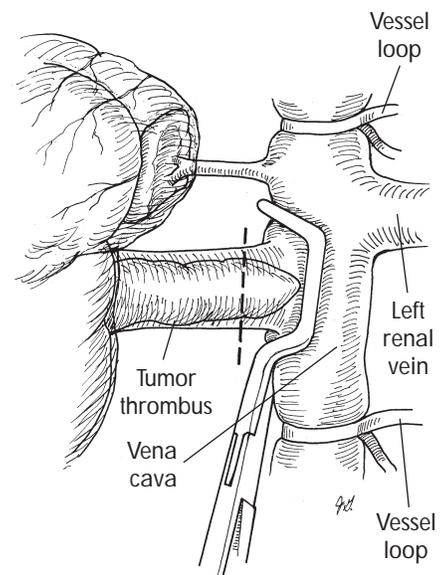
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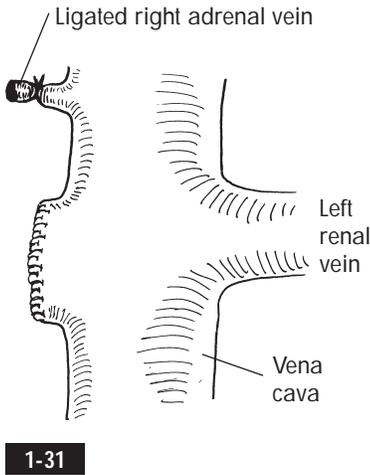
From Montie JE: Inferior vena cava tumor thrombectomy. In Montie JE, Pontes JE, Bukowski RM, editors: *Clinical management of renal cell carcinoma*, Chicago, 1990, Mosby.

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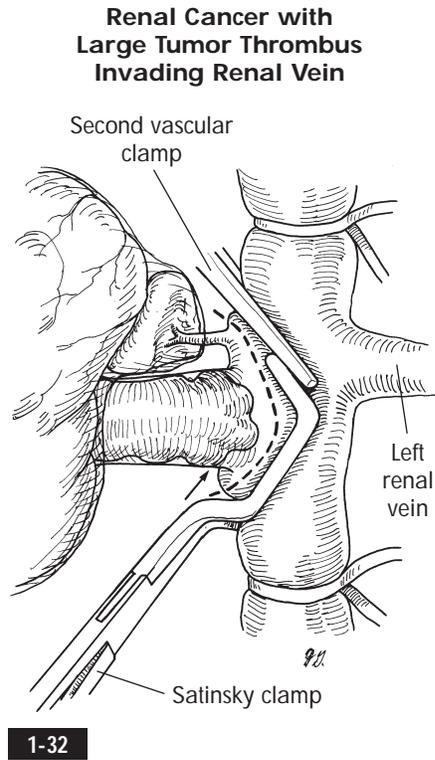
**Right Renal Vein with Tumor Thrombus**



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1-32

FIG. 1-31. The surgeon can close the venotomy with a double-arm stitch (4-0 Prolene), making two rows of a running stitch.

Rarely, the tumor thrombus has invaded the vascular walls.

FIG. 1-32. At times, a Satinsky clamp may be insufficient to go around a large, irregular configuration of a tumor thrombus, so an additional clamp is needed for complete occlusion.

To the extent possible, the surgeon should leave a part of the vena cava in continuity for venous flow return from the contralateral renal vein and lower vena cava.

The surgeon should wait after the clamps are placed and then check for hemodynamic changes by the blood pressure changes.

FIG. 1-33. Partial excision of the vena cava may be necessary with tumor invasion, and a double row of stitches for closure of the venotomy (4-0 Prolene double-arm sutures) should be performed. Small bleeding sites may be rein-

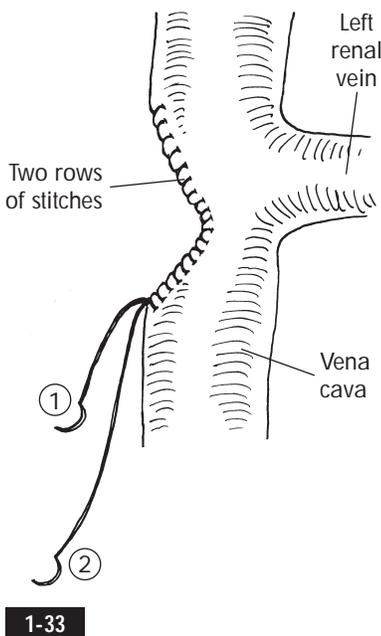
forced with an additional Prolene stitch.

#### Complete Occlusion of Vena Cava for Tumors Below Hepatic Veins

In situations in which complete occlusion of the vena cava is anticipated, the surgeon should first isolate the vena cava and ligate the lumbar veins in the region concerned.

FIG. 1-34. The usual collateral venous channels back to the heart are the azygos and hemiazygos veins. When these veins are obstructed by tumor involvement or scarring, then the inferior mesenteric vein becomes a main collateral channel and will be enlarged and dilated.

FIG. 1-35. If the tumor thrombus is higher than expected, it is important to first ligate and divide the small four to six veins to the caudate lobe of the liver. This maneuver gives the surgeon an extra 2 to 3 cm for more maneuverability during the vascular occlusion of the vena cava.

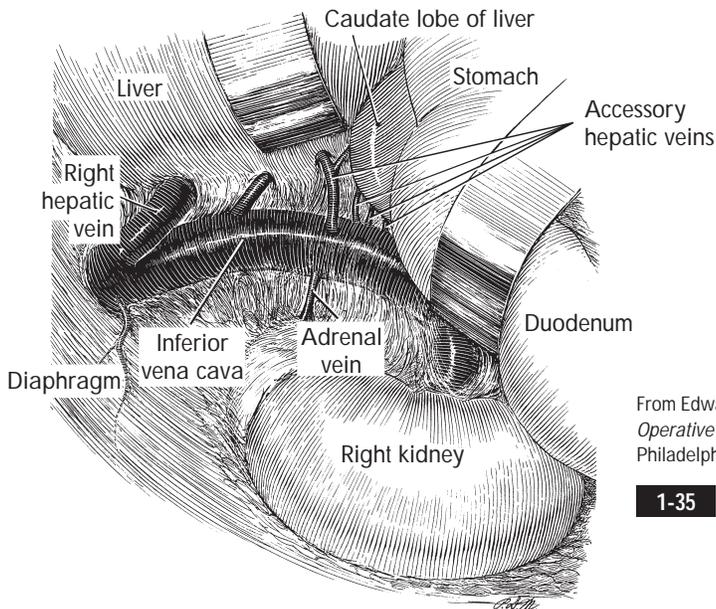
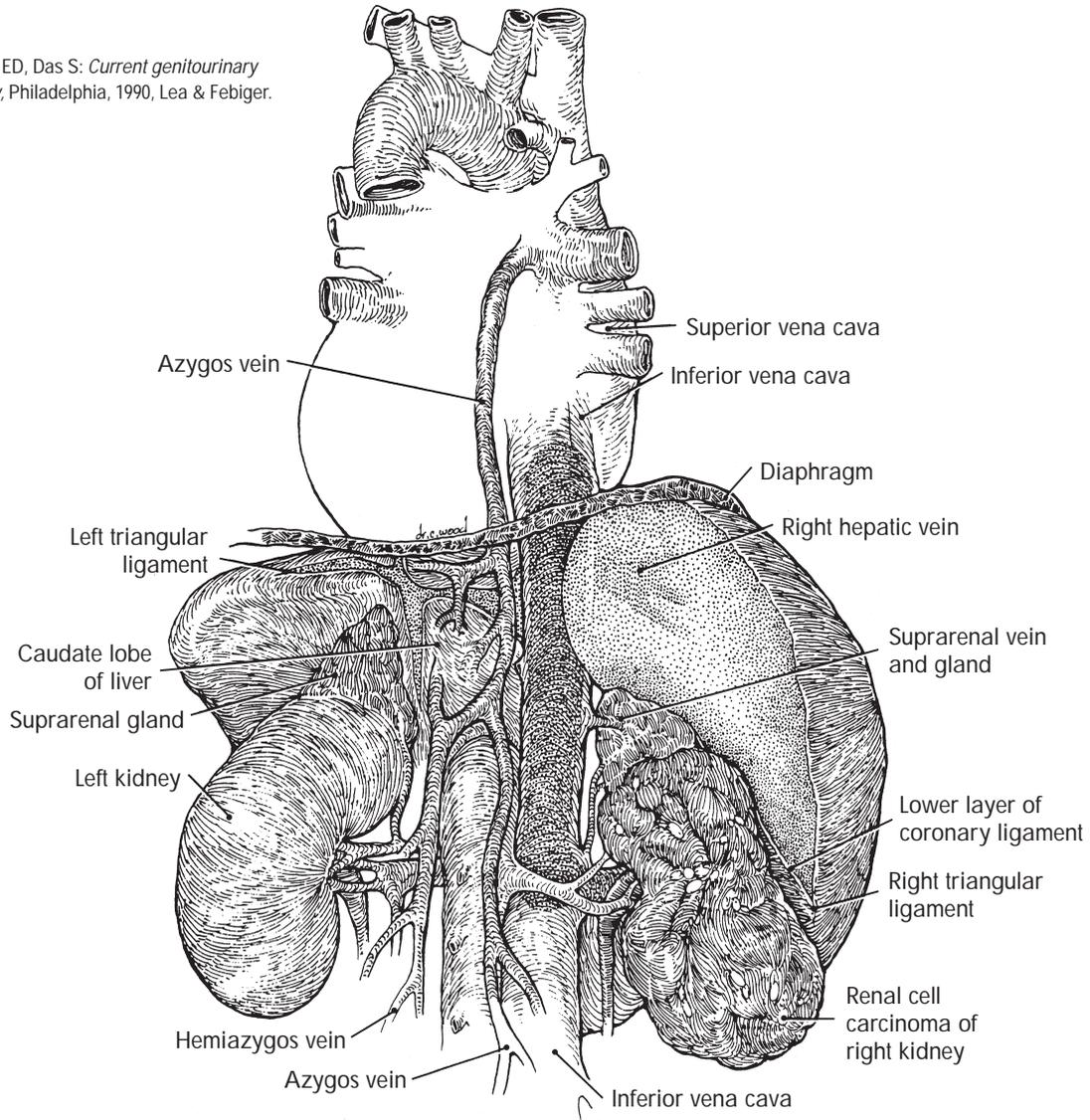


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Posterior View of Retroperitoneal Anatomy

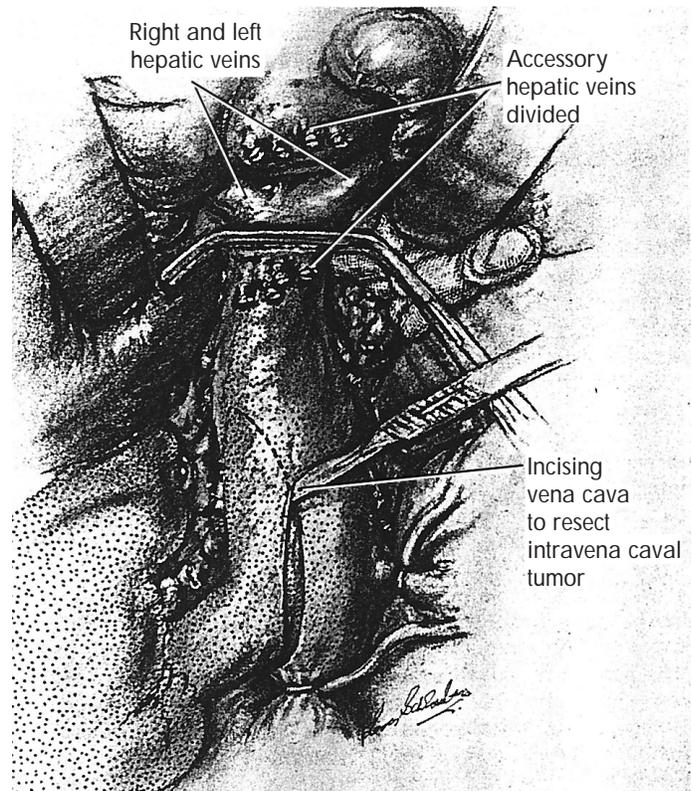
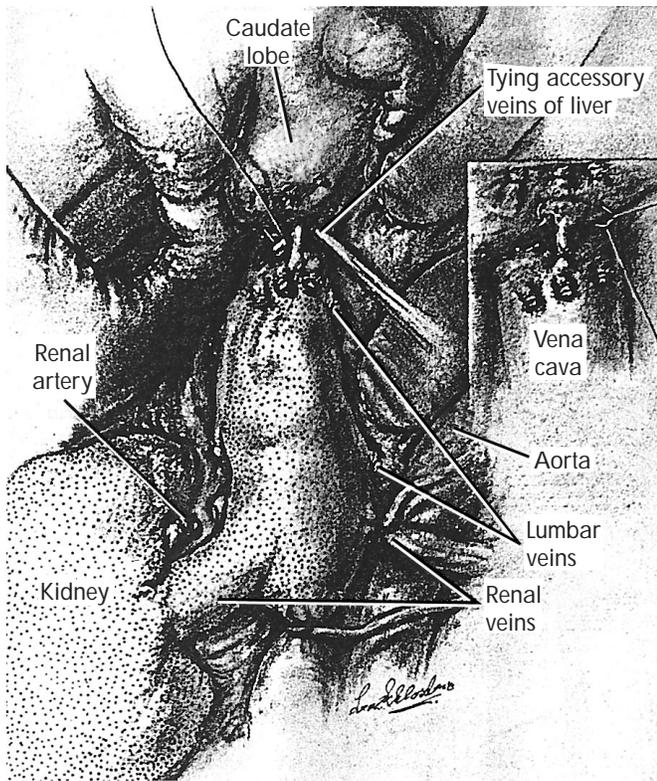
From Crawford ED, Das S: *Current genitourinary cancer surgery*, Philadelphia, 1990, Lea & Febiger.

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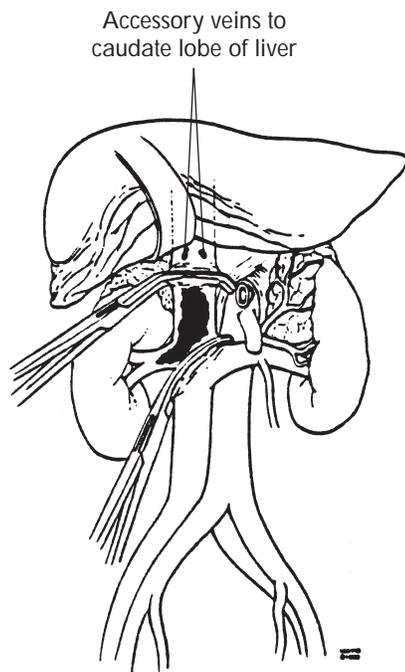
From Edwards EA, Malone PD, MacArthur JD: *Operative anatomy of abdomen and pelvis*, Philadelphia, 1975, Lea & Febiger.

1-35



From Marshall FF et al: *J Urol* 139:1166, 1988.

1-36



From Blute ML, Zincke H: Surgical management of renal cell carcinoma with intracaval involvement, *AUA Update Series*, lesson 17, vol XIII, 1994.

1-37

FIGS. 1-36 AND 1-37. The renal artery should be ligated as early as possible because the ligation will cause the renal tumor as well as the tumor thrombus to shrink. We prefer to use Rummel vascular tourniquets rather than vascular clamps whenever possible because they are more maneuverable and less traumatic to the vasculature.

The order of vascular occlusion should be as follows:

- 1 Ligation of veins to the hepatic veins.
- 2 Ligation of the renal artery.
- 3 Temporary occlusion of the vena cava proximally (cranial) and distally (caudad) and contralateral renal vein.

#### Closure of Cavotomy

FIG. 1-38. After the cavotomy and extraction of the tumor thrombus, the cavotomy can be reapproximated with a double-arm stitch (4-0 Prolene). When the cavotomy

is longer than the length of the Satinsky clamp, the surgeon may need to first reapproximate part of the venotomy and then apply the Satinsky clamp for closure of the remaining venotomy with the “venting” procedure. Reapproximation should be performed from cephalad to caudad.

**Restoration of Vascular Continuity**

The sequence of vascular restoration is important in the evacuation of trapped air and tumor and/or tissue debris before the systemic circulation is restored. The “venting” procedure is as follows:

- 1 Patient in 20-degree Trendelenburg position
- 2 Contralateral renal vein restoration
- 3 Aorta restoration if occluded
- 4 Distal (caudad) vena cava restoration with “venting” by temporary unclamping of the Satinsky clamp
- 5 Proximal (cranial) vena cava restoration with “venting”

The residual venotomy is then closed with two rows of double-arm stitches (4-0 Prolene).

**LARGE RIGHT-SIDED RENAL CANCER**

In situations in which safely identifying and isolating the renal pedicle and the adrenal vein are impossible, the surgeon should first mobilize the bowel as if to perform retroperitoneal lymph node dissection.

The surgeon should continue the right incision lateral to the ascending colon, come around the cecum, and up the mesentery to the ligament of Treitz.

The inferior mesenteric vein should be ligated and divided and the ligament of Treitz divided if necessary (see pp. 53-54). The bowel is placed in a bowel bag and reflected cephalad on the chest. This maneuver allows the surgeon to work right over the great vessels.

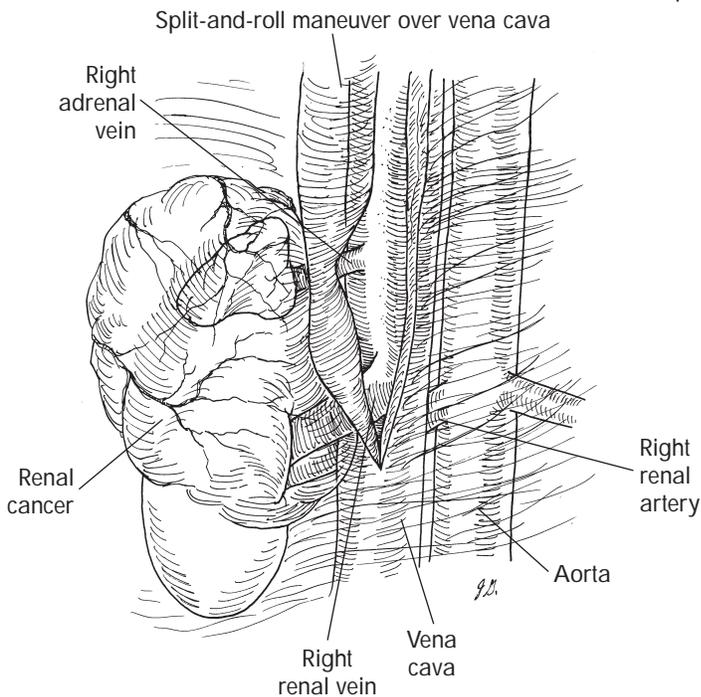
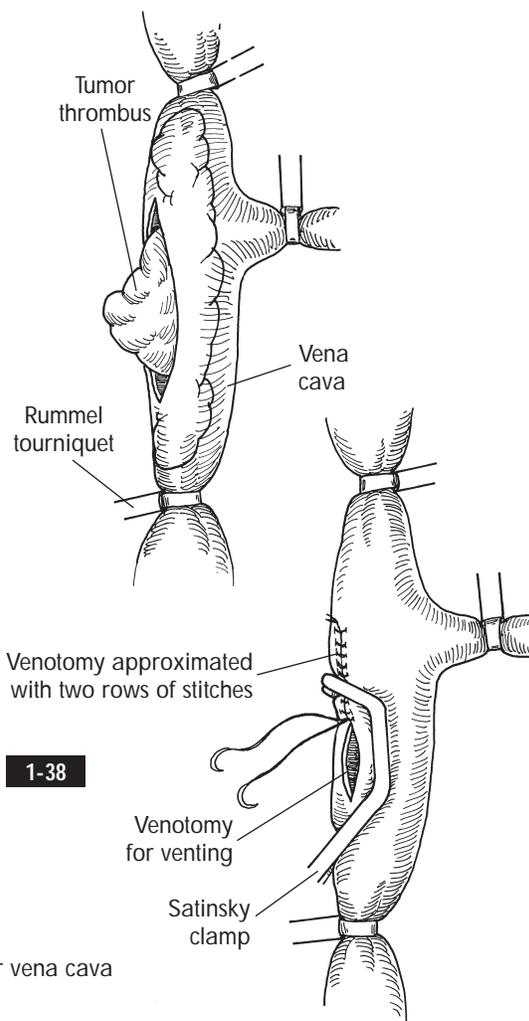
FIG. 1-39. As in a retroperitoneal lymph node dissection, the surgeon performs a split-and-roll maneuver over the vena cava and the aorta (see p. 58) and works laterally to expose the right renal artery, renal vein, and adrenal vein.

The surgeon should always tie the renal artery first and then the vein. The arterial occlusion often will decrease the volume of the renal mass. Double proximal ties (0 silk) and one distal tie are placed for both the artery and vein.

The adrenal vein should not be clipped but tied (3-0 or 4-0 silk).

Clips should not be used on the tumor side because they often slip and lead to back-bleeding.

**Closure of Venotomy After Tumor Extraction**



**LEFT-SIDED RENAL CANCER**

The surgeon incises the parietal peritoneum along the line of Toldt lateral to the descending colon from the sigmoid colon all the way up and around most of the splenocolic ligament.

Before the surgeon divides the splenocolic ligament, the Finochetto retractor is placed between two dry laparotomy pads against the ribs and opened. This maneuver provides excellent exposure for the proximal diaphragmatic division and the splenocolic ligament division.

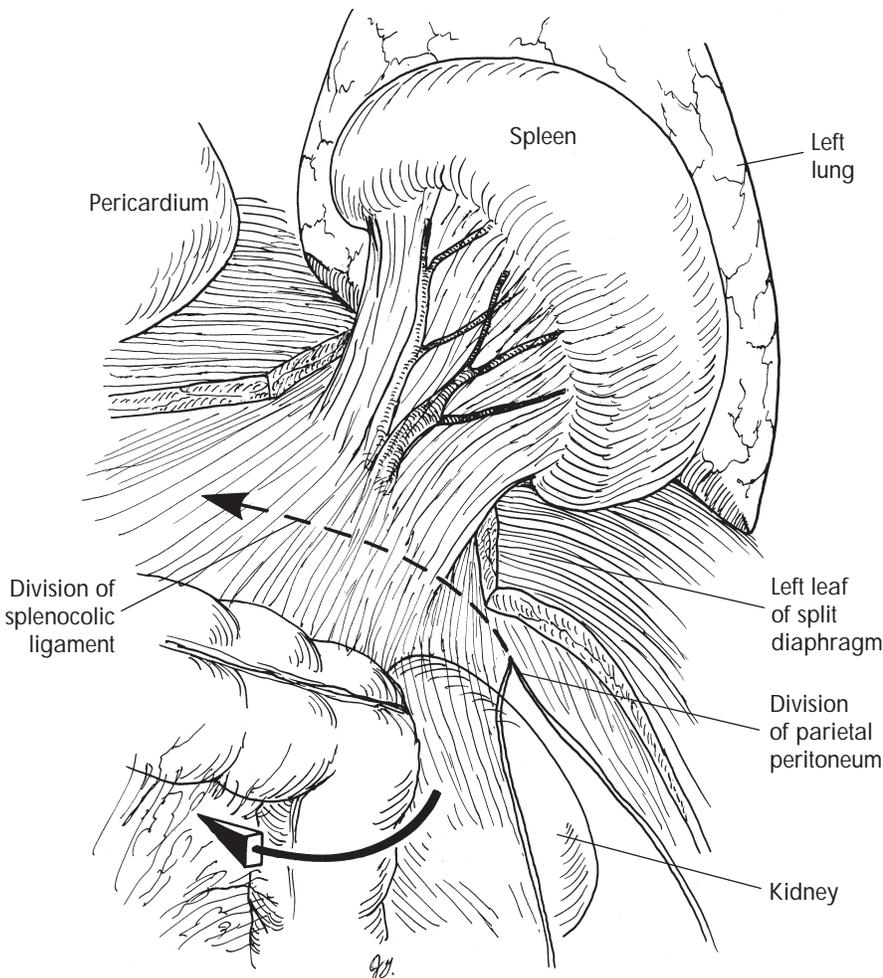
Because the spleen is smaller than the liver, the diaphragmatic incision does not need to be as extensive as on the right side.

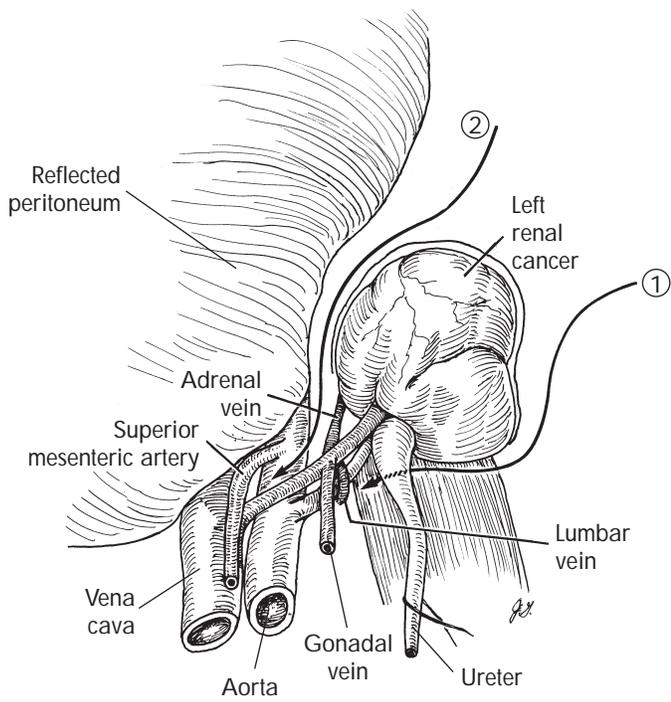
FIG. 1-40. The patient is positioned in the Trendelenburg position, and the spleen is delivered into the pleural cavity.

FIG. 1-41. We prefer first to dissect a plane between the kidney and the psoas muscle (1), then isolate the ureter for later ligation and division, and then dissect a plane between the parietal peritoneum and the renal pedicle (2).

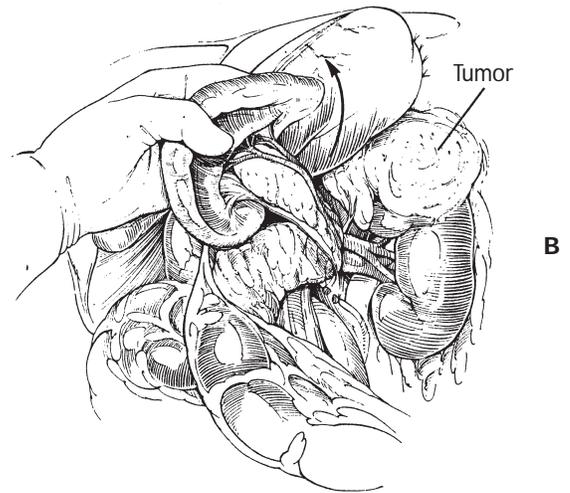
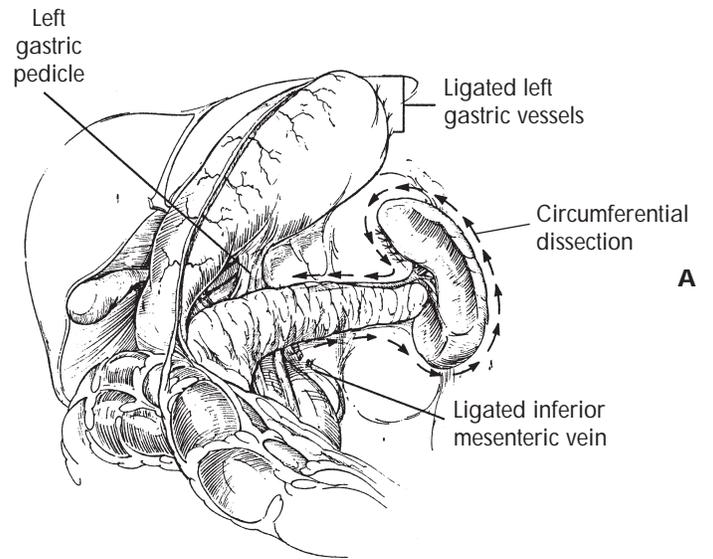
FIG. 1-42. An alternative to placing the spleen into the pleural cavity is performing a medial splenopancreatic roll. This technique is especially useful in the case of large, upper pole tumors. The left gastric vessels and the inferior mesenteric vein are ligated, and circumferential dissection around the splenopancreatic segment is performed. This incision extends around the splenic pedicle and continues around the fundus of the stomach to a point near the esophageal hiatus (A). Using the spleen as a handle, the surgeon mobilizes the splenopancreatic segment, freeing its posterior attachments (B).

FIG. 1-43. This maneuver displaces the spleen and pancreas into a medial position, thus defining the plane between the Gerota's fascia and the peritoneum and exposing the renal pedicle and the entire retroperitoneum for surgery.<sup>3</sup>



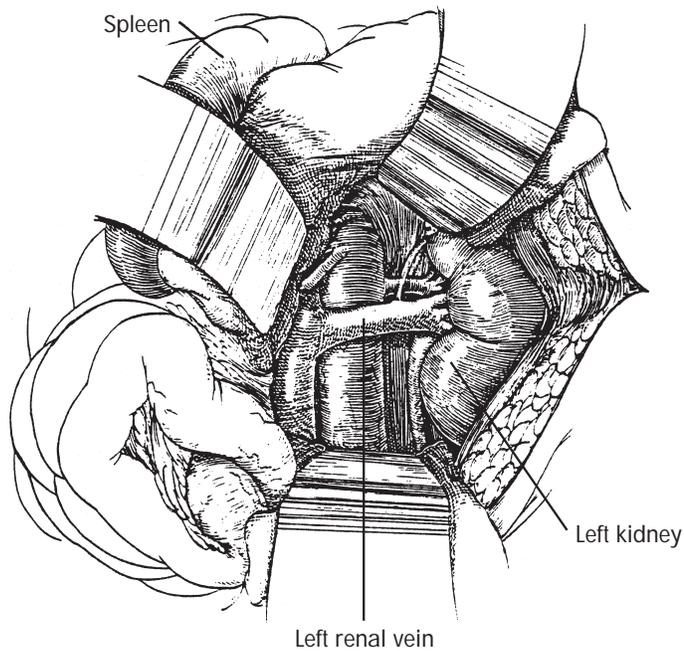


1-41



From Marsh CL: *Contemp Urol* 6(8):15-20, 1994.

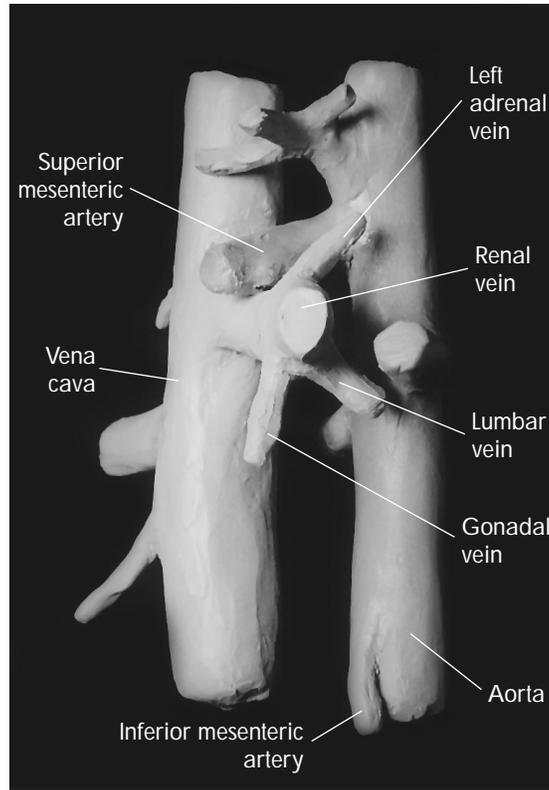
1-42



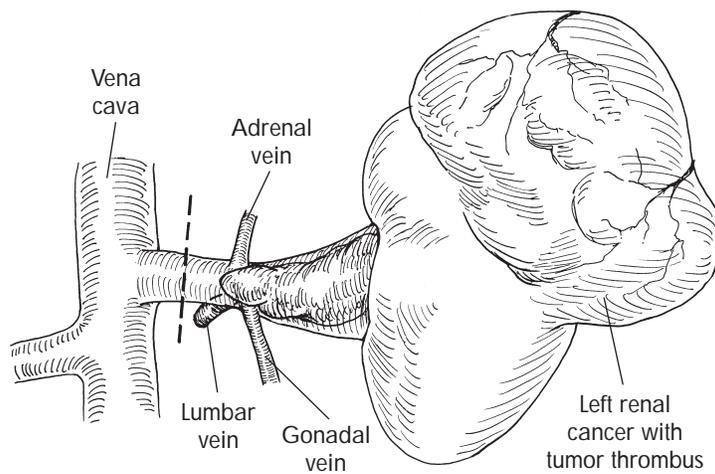
From Crawford ED, Borden TA, editors: *Genitourinary cancer surgery*, Philadelphia, 1982, Lea & Febiger.

1-43

Left Lateral View of Renal Vasculature



1-44



1-45

FIGS. 1-44 AND 1-45. On the left side, the venous tributaries from the renal vein are the following:

- 1 Gonadal vein
- 2 Adrenal vein
- 3 Lumbar vein

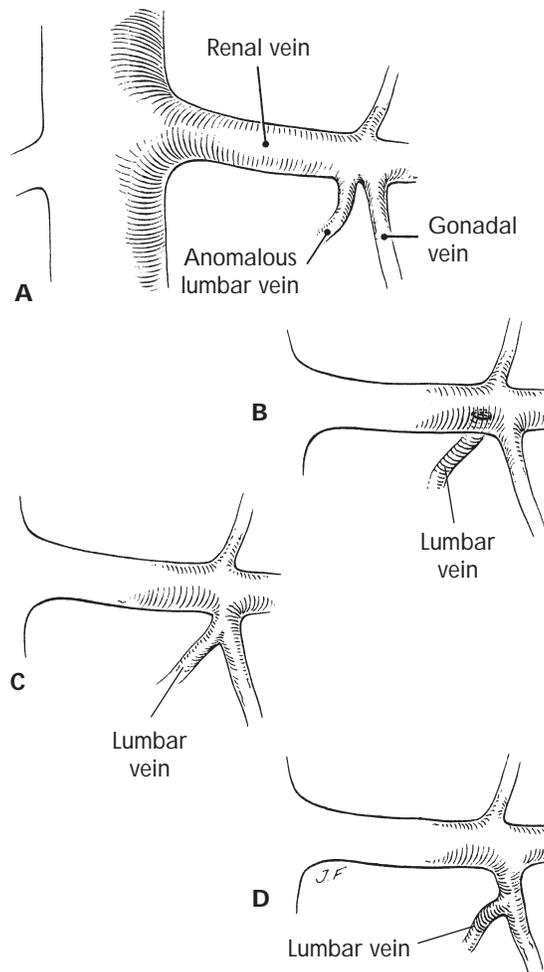
If all three tributaries from the renal vein have been divided, the surgeon's best option is to ligate and divide the renal vein more proximally or distally, especially in cases with a small tumor thrombus.

FIG. 1-46. Of the three, the lumbar vein is the most troublesome because it drains from the posterior aspect, often is not visualized, and can have anomalous anatomic variations.

It is wise first to ligate the adrenal vein, gonadal vein, and lumbar vein before performing the nephrectomy.

Again, the renal artery should always be ligated first to decrease the volume of renal mass.

### Variations in Anatomy of Lumbar Vein



From Crawford ED, Borden TA, editors:  
*Genitourinary cancer surgery*,  
 Philadelphia, 1982, Lea & Febiger.

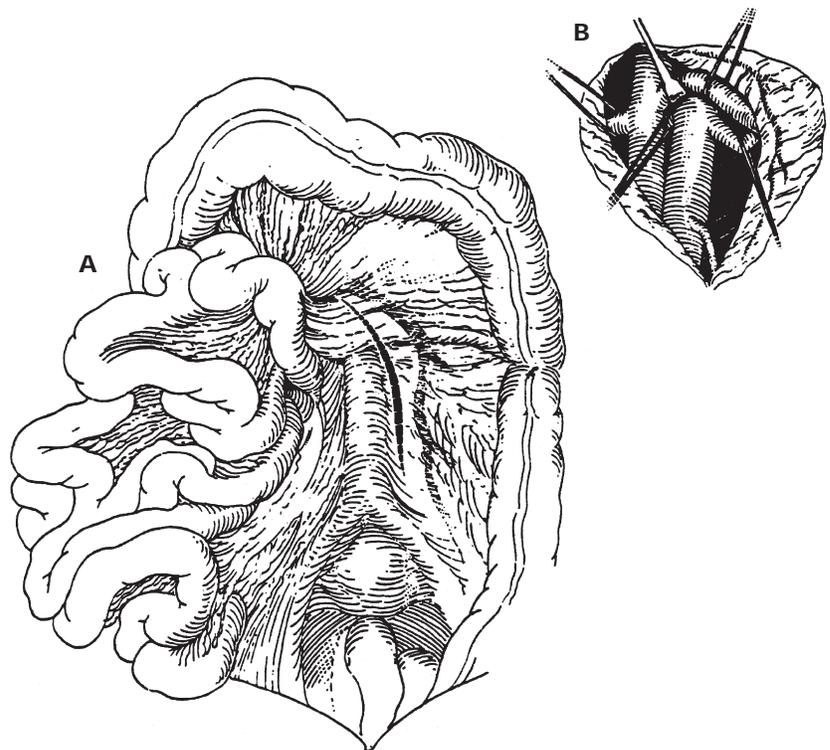
**MEDIAL LARGE LEFT RENAL  
CANCER**

If the surgeon has difficulty even approaching the renal pedicle because of a large, medially placed cancer, an alternative maneuver should be used.

As on the right side, exposure should be gained by an incision carried from the foramen of Winslow around the ascending colon and cecum, and toward the ligament of Treitz.

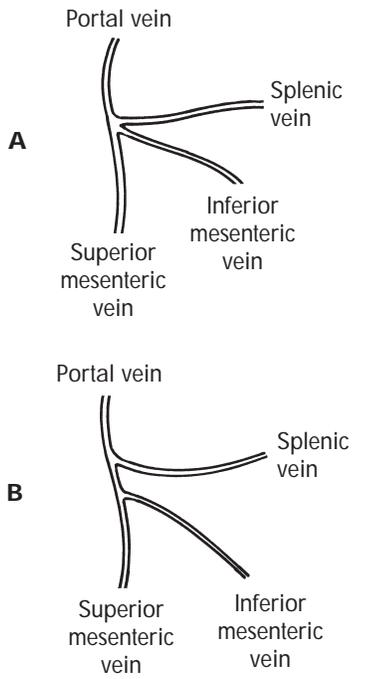
FIGS. 1-47 THROUGH 1-50. With large left-sided renal tumors or retroperitoneal masses for which it is necessary to mobilize the superior

mesenteric artery and part of the pancreas, the surgeon should divide the inferior mesenteric vein to gain the maximal exposure of the vasculature and the adjacent organs. This approach differs from the mesenteric incision, which is made medial to the inferior mesenteric artery and is used in cases of trauma.<sup>13</sup> The inferior mesenteric vein varies in its communication with the portal venous drainage and may act as a barrier for a full exposure of the great vessels and their major branches (more commonly configuration 1 than 2 in Fig. 1-49).

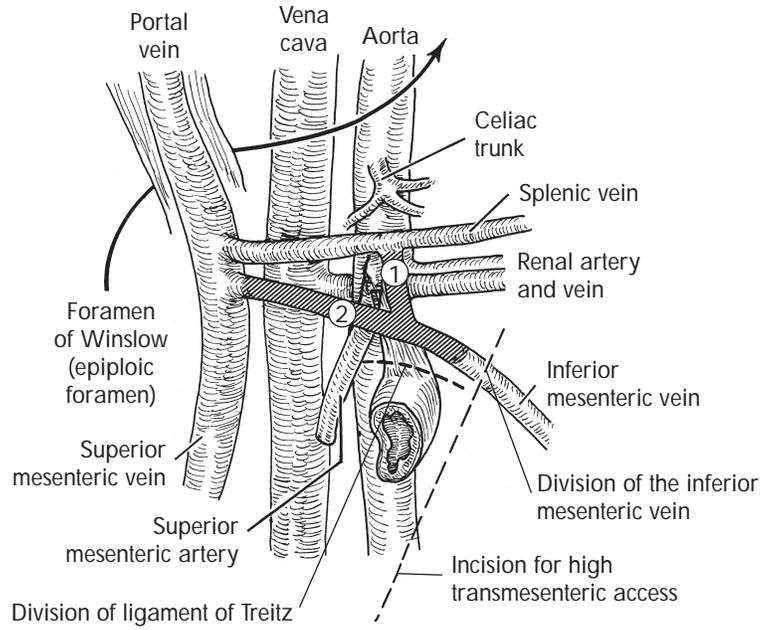


From McAninch JW, Carroll PR: *J Trauma* 22:285, 1982.

**Variations in Anatomy of Inferior Mesenteric Vein**

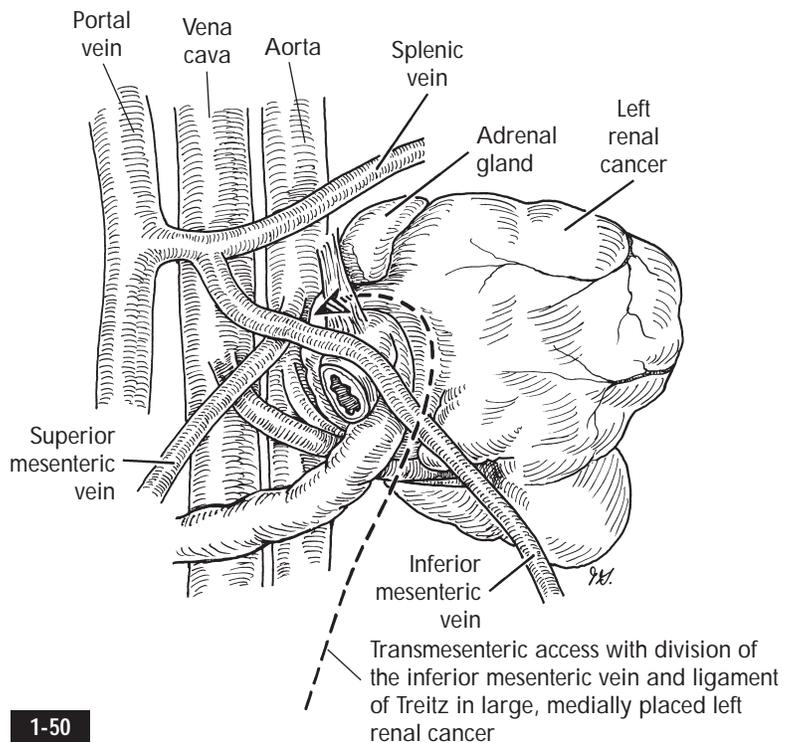


1-48

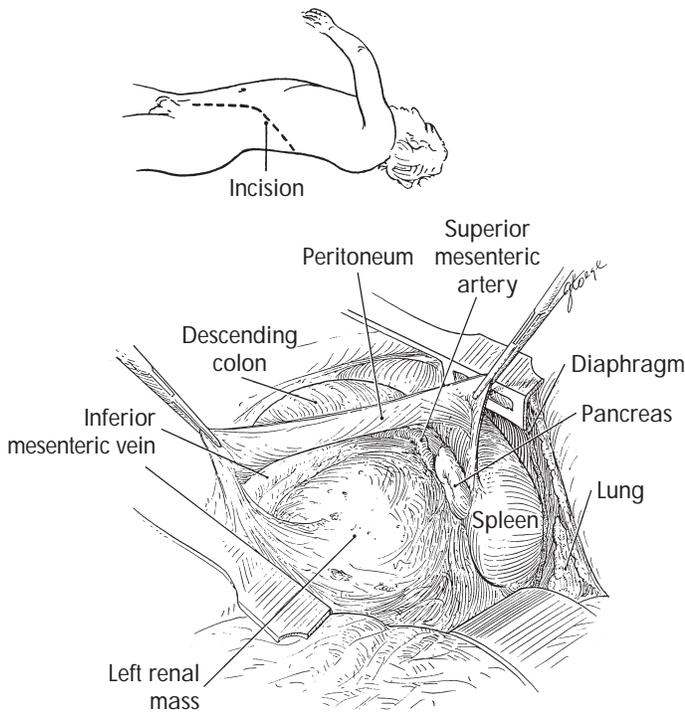


1, most common configuration of inferior mesenteric vein  
2, possible configuration of inferior mesenteric vein

1-49

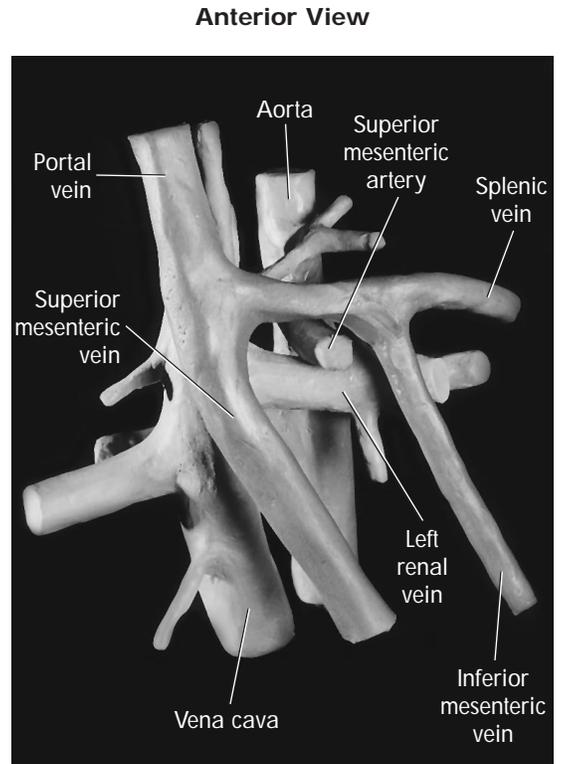


1-50

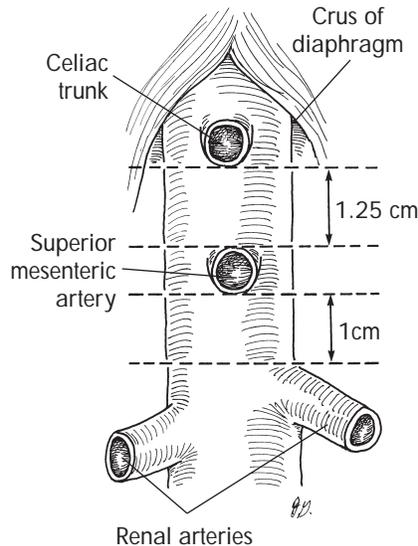


From Skinner DG: *Urol Clin North Am* 5:253, 1978.

1-51



1-52



1-53

FIGS. 1-51 AND 1-52. By following the inferior mesenteric vein up to its junction with the splenic vein, the surgeon can identify the region of the superior mesenteric artery,<sup>14</sup> an important landmark for both right- and left-sided dissections. Once the inferior mesenteric vein and the ligament of Treitz are divided (there are small vessels within the ligament), the bowel is reflected cephalad.

FIG. 1-53. The left renal artery is only 1 cm below the superior mesenteric artery.

### SUPERIOR DISSECTION OF ADRENAL GLAND

For both left and right adrenal gland resection, the first maneuver is to ligate and divide the adrenal vein(s). The surgeon must slide the left fingers on either side of the adrenal gland and apply a downward traction while the right hand applies clips above the gland. The residual lymphatics and the ureter are divided to complete the excision of the renal mass.

### CLOSURE OF DIAPHRAGM AND RIB REAPPROXIMATION

FIG. 1-54. The reapproximation of the diaphragm is best performed by a Teflon felt pledget “sandwiching” technique, whereby a mattress stitch (0 silk) and two felt pledgets sandwich the two leaves of the diaphragm. These pledgets are placed on the abdominal side rather than on the pleural side.

The ribs are reapproximated using two interrupted stitches (1-0 Prolene).

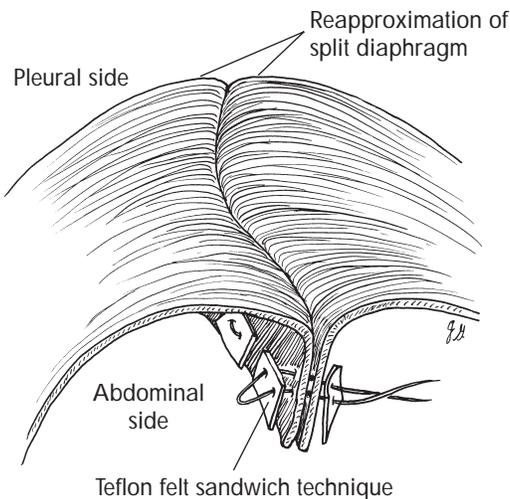
FIG. 1-55. One or two chest tubes are placed, and the more dependent tube suctions fluid and blood if the patient is placed in a semi-upright position (head up 30 degrees) postoperatively.

### LIVER INJURIES

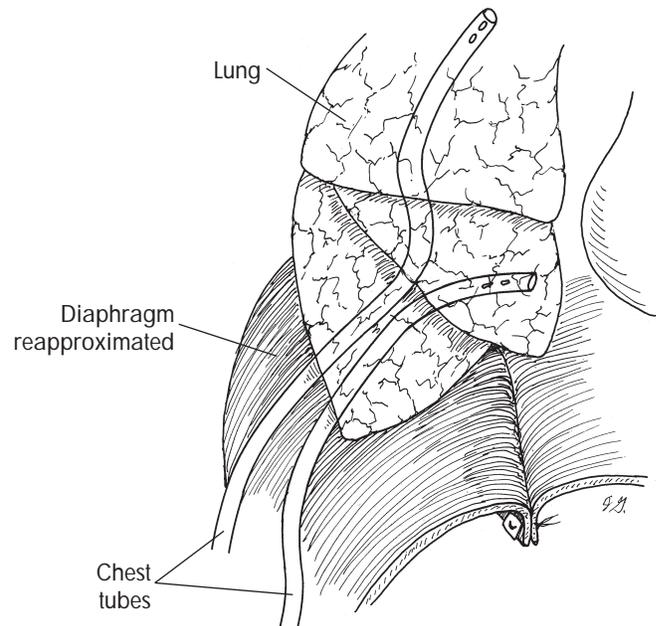
When inadvertent blunt trauma to the liver occurs secondary to excessive pressure from a retrac-

tor blade, the following maneuvers are useful to stop liver hemorrhages:

- 1 The Pringle maneuver with finger compression anterior to the foramen of Winslow will occlude the hepatic artery<sup>6</sup> (see pp. 8-9).
- 2 The surgeon can manually compress the lacerated area.
- 3 Avitene placed between a Surgicel sandwich can be packed into the laceration with compression.
- 4 Fibrin glue (Hemaedics, Inc., Malibu, Calif.) can be used to occlude the wound.
- 5 The argon beam coagulator is a useful adjunct (Birtcher/Solos Medical Systems, Irvine, Calif.).
- 6 A Teflon felt pledget sandwiching technique applied to either side of the laceration usually occludes the bleeding edges.



1-54



1-55

## KEY POINTS

### THORACOABDOMINAL INCISION

- An eighth or a ninth interspace incision is made from the posterior axillary line all the way across the contralateral rectus abdominis muscle.
- A straight diagonal incision is preferable to the combination of a diagonal incision with a vertical extension below.
- The diaphragm is split toward the great vessels, first without the retractor and then with the Finochetto retractor opened.
- The peritoneum is opened and nasal gastric tube is positioned.

### RIGHT RENAL CANCER

- Incision and mobilization are performed along the line of Toldt up to the foramen of Winslow.
- The Finochetto retractor should be placed with a dry laparotomy pad on each side of the ribs to prevent slippage.
- Once the Finochetto retractor has been opened halfway, the diaphragm should be incised all the way to the central tendon, avoiding any major phrenic branches.
- The incision along the line of Toldt lateral to the colon is now extended medially into the foramen of Winslow.
- The three ligaments of the liver are divided.
- The patient is placed in the Trendelenburg position and the liver is mobilized into the pleural cavity.
- The surgeon first reflects the colon medially and then performs a Kocher maneuver of the duodenum.
- The vena cava and renal pedicle are exposed.
- It is important to divide the adrenal vein early.
- The renal artery is divided before the renal vein.

- The ureter and gonadal vessels are divided.
- Large tumor thrombus in the vena cava below the hepatic veins may require ligation of lumbar veins, veins to the caudate lobe of the liver, and complete occlusion of the vena cava.
- The order of restoration of venous continuity after vena cavotomy is important to avoid air and debris embolus.
- For large tumors in which exposing the renal pedicle is difficult, the incision must be continued around the cecum up the ligation of Treitz to gain medial access to the great vessels and their branches.
- A split-and-roll maneuver should be carried out over the vena cava to expose the renal vein and the adrenal vein and over the aorta to expose the renal pedicle.
- Arterial ligation, performed before venous occlusion, decreases the volume of the renal mass.
- The tissues holding the adrenal gland from above are clipped and divided from lateral to medial.

### LEFT-SIDED RENAL CANCER

- Incision and mobilization are performed along the line of Toldt lateral to the descending colon up the splenocolic ligament.
- Before division of the splenocolic ligament, the Finochetto retractor is put in place with two dry laparotomy pads.
- Diaphragmatic division is completed but it does not extend to the central tendon.
- Division of the splenocolic ligament is performed.
- The patient is placed in the Trendelenburg position and the spleen is delivered into the pleural cavity.
- The left colon is reflected medially.
- The gonadal vein, adrenal vein, and lumbar vein are ligated and

divided before nephrectomy is performed.

- The renal artery and renal vein are isolated.
- With a large medial tumor, the incision is made on the line of Toldt lateral to the right colon and is carried from the ascending colon, around the cecum, and along the route of the mesentery.
- The aorta and the vena cava are exposed by a split-and-roll maneuver of the overlying tissue and the renal vein and artery are isolated from a medial approach.
- Closure of the diaphragm is performed with a pledget sandwiching technique.
- Chest tubes are placed and the ribs are reapproximated.

#### POTENTIAL PROBLEMS

- *Liver laceration:* Six options: perform Pringle maneuver, apply manual compression, apply compression with Surgicel, seal wound with fibrin glue, use argon beam coagulator, perform Teflon felt sandwich technique, or call for surgical consultation for possible partial liver resection
- *Splenic laceration:* Proceed as for liver laceration → if hemorrhage is severe, perform splenectomy
- *Inferior mesenteric artery injury:* Ligate and proceed with surgery
- *Adrenal vein and vena cava laceration:* Apply three-finger compression of proximal vena cava → clamp vena cava → close with running stitch (4-0 Prolene)
- *Difficult exposure of left renal pedicle because of large tumor:* Divide root of mesentery → divide inferior mesenteric vein → isolate great vessels → perform split-and-roll maneuver → identify superior mesenteric artery and pancreas → isolate and divide left renal artery and then renal vein
- *Diaphragm muscle torn in reapproximation:* Use Teflon felt pledget sandwich technique

#### SPLenic HEMORRHAGE AND SPLENECTOMY

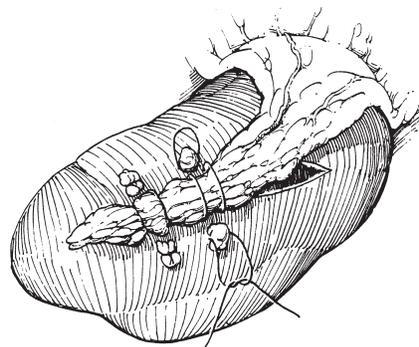
Vigorous retractor compression especially by the Harrington retractor can lead to contusions and lacerations of the liver, pancreas, and spleen. In most cases manual compression alone is sufficient to arrest small injuries. When splenic laceration results in more persistent bleeding, other maneuvers must be considered.

##### Minor Splenic Hemorrhage

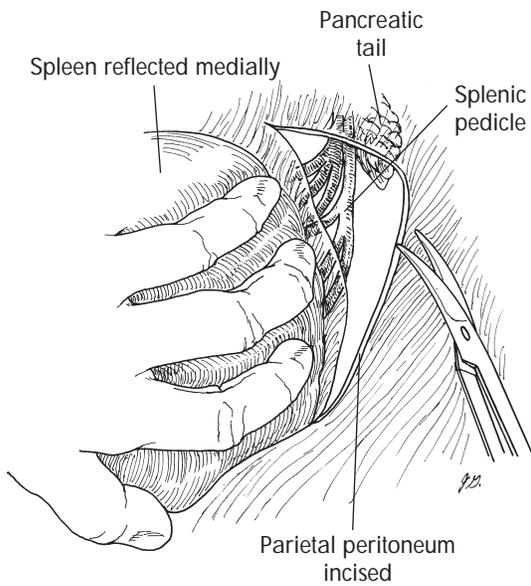
If there is a small wedge of macerated spleen with a slow hemorrhage, the surgeon should first try manual compression.

An alternative is to insert a Surgical sandwich with Avitene in between using manual compression.

FIG. 1-56. If the bleeding continues, the surgeon can apply synthetic hemostatic gauze or omentum over the defect and place mattress sutures (0 chromic) to secure it. Bolsters of hemostatic gauze can be inserted under the suture loops, or a compressive Teflon felt sandwich technique using a mattress stitch (0 chromic) can be performed. The hemostatic gauze or Teflon felt provides support on both sides of the organ and prevents the suture from tearing through the organ while providing compression. We use the sandwiching technique for splenic, liver, kidney, and diaphragmatic closures (see Fig. 1-54).



From Hinman F Jr: *Atlas of urologic surgery*. Philadelphia, 1989, WB Saunders.



1-57

**Massive Hemorrhage from Splenic Laceration**

**Posterior Approach**

FIGS. 1-57 AND 1-58. When sudden splenic hemorrhage obliterates the operative field, the surgeon's first maneuver is to place the *left palm* over the spleen with the fingers as close to the pedicle as possible. The surgeon should rotate the spleen medially while compressing the organ.

Instead of using suctioning, the surgeon and assistant should literally "*scoop*" the blood out with dry laparotomy pads. This technique is the easiest and fastest way to clear the operative field of large amounts of blood that may be partially coagulated. Suctioning is useful only after the bulk of blood has been evacuated.

With the right hand, the surgeon can now divide the parietal peritoneal attachments inferiorly, laterally, and then superiorly and occasionally on the diaphragm. The lower pole is freed, if adherent.

As the spleen is rotated medially, the surgeon must be careful to expose the splenic pedicle while avoiding injury to the pancreatic tail.

The critical maneuver is to find *not* the branches but the more proximal main splenic artery and

ligate it. This ligation will slow down the bleeding immediately as well as decrease the size of the spleen. The surgeon can then continue the posterior approach, divide the splenic vein, and complete the splenectomy.

**Anterior Approach**

If the posterior approach is difficult, the assistant's dominant hand can be placed over the region of the splenic pedicle and compression applied while the surgeon focuses on an anterior approach.

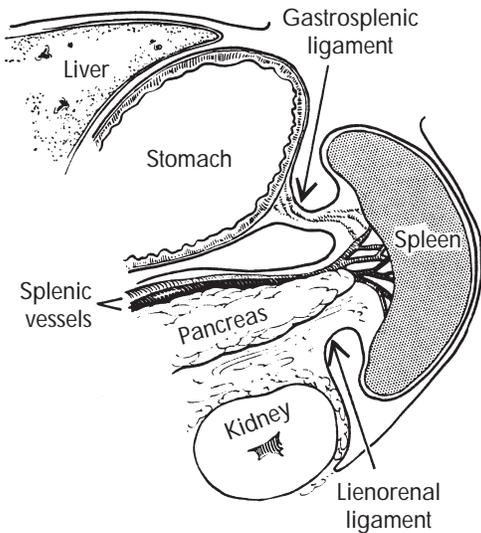
Even after ligation of the splenic artery from behind, in some situations access for the splenectomy is better using the anterior than the posterior approach.

FIGS. 1-58 AND 1-59. The gastrosplenic ligament, containing the left gastroepiploic artery and the short gastric arteries, is ligated and divided. This maneuver separates the stomach from the omentum.

The exposure should be such that the greater curvature of the stomach can be reflected cephalad, providing a window to the pancreas and the splenic pedicle.

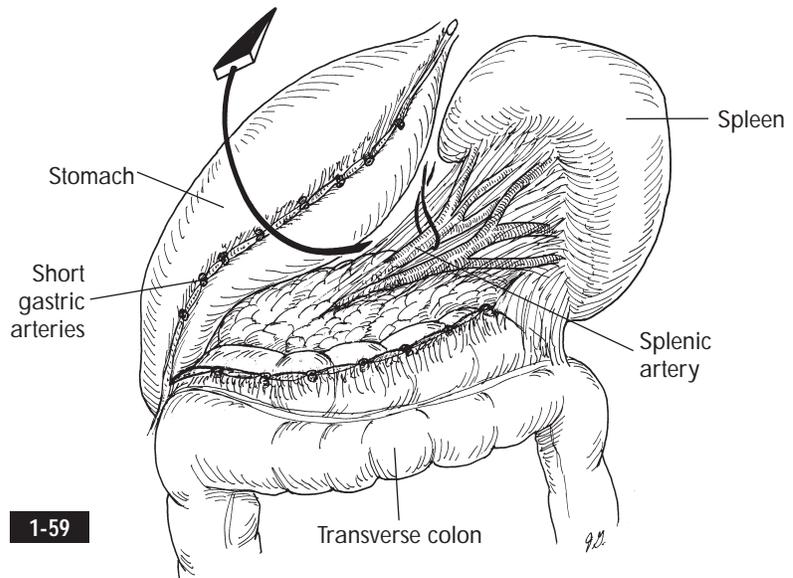
Avoiding any injury to the pancreas, the surgeon then ligates and divides both the splenic artery and vein.

**Spleen and Its Relations As Seen From Below**



From Bowers WF, Hewlett TH, Thomas GJ: *Manual of surgical technique*, Springfield, Ill, 1963, Charles C Thomas.

1-58



1-59

## KEY POINTS

### POSTERIOR APPROACH

- Using the left hand, the surgeon medially rotates the spleen while compressing the organ.
- Evacuation of blood is performed using laparotomy pads.
- Via the posterior approach, the peritoneal attachments are divided and the splenic pedicle and pancreatic tail are identified.
- Division of the peritoneal attachments and short gastric arteries is performed.
- The arterial system of the splenic artery is ligated.
- The splenic vein is ligated.

### ANTERIOR APPROACH

- The gastroepiploic and short gastric arteries are divided, separating the omentum from the stomach.
- The stomach is reflected superiorly, and ligation and division of the splenic artery and then the splenic vein are performed.

## POTENTIAL PROBLEMS

- **Massive hemorrhage:** Apply compression to the spleen → evacuate blood with dry sponge (do not use suction device because it is not quick enough)
- **Posterior dissection with injury of tail of pancreas:** Continue procedure and consider a surgical consultation for inspection and drain placement
- **Spleen is too large to use posterior approach:** Use the anterior approach to ligate the splenic artery first

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