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.

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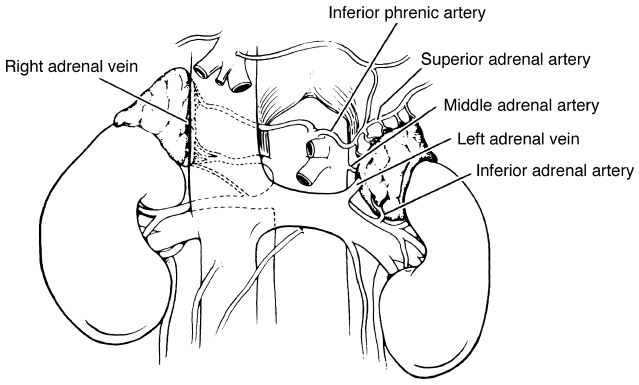

Fig. 2.1

Normal adrenal blood supply.

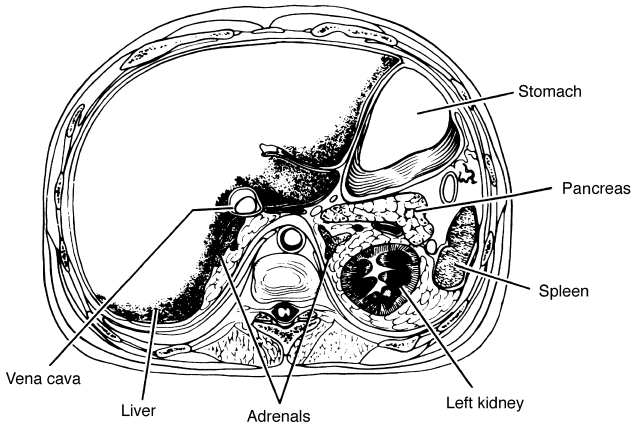

Fig. 2.2

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

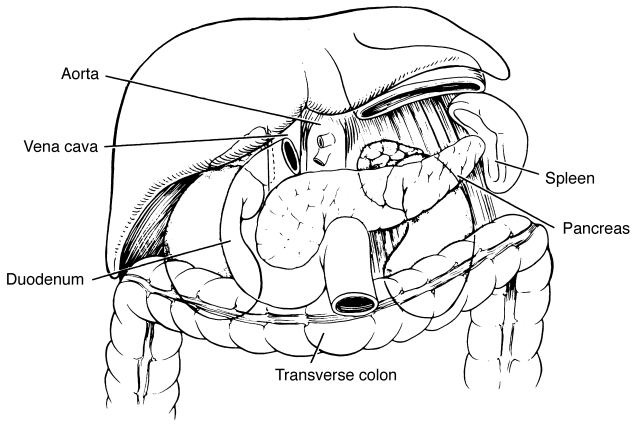

Fig. 2.3

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

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.

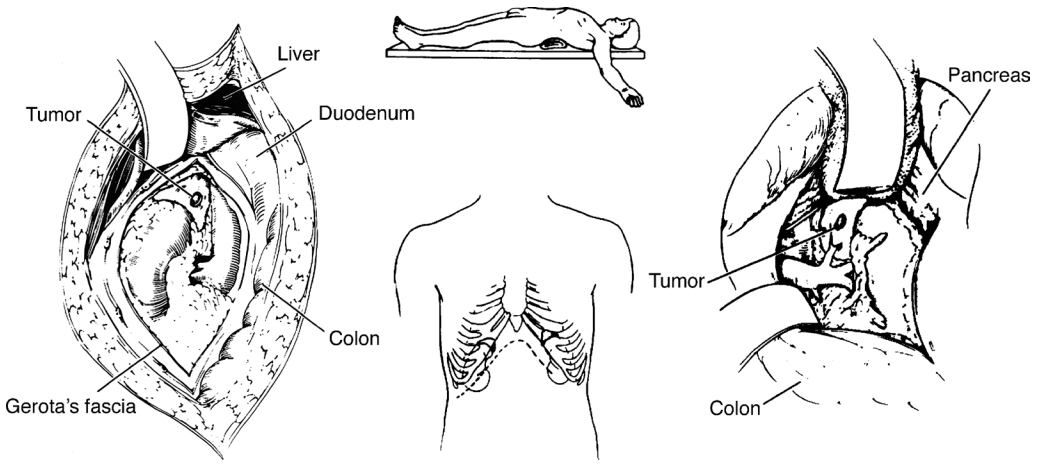

Fig. 2.4

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.

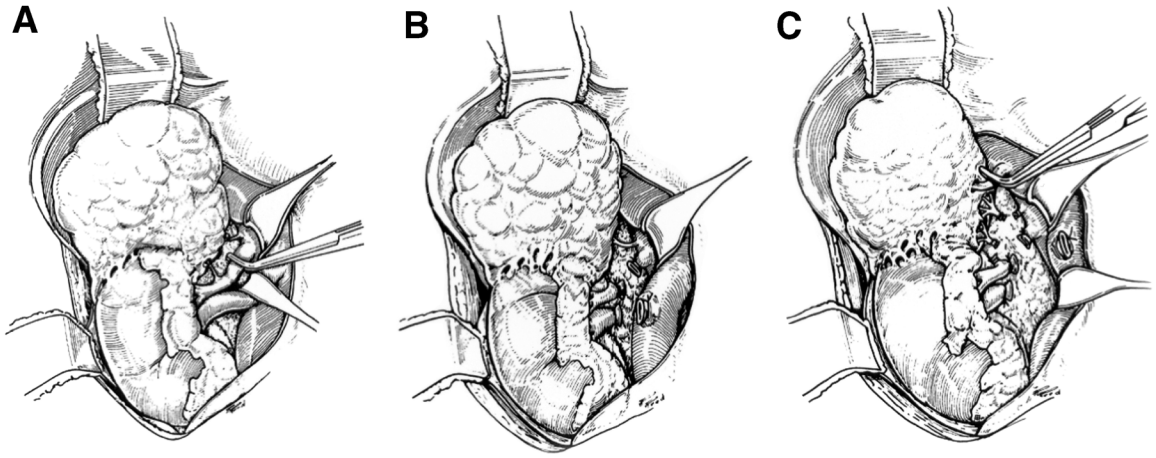

Fig. 2.5

Technique of radical nephroadrenalectomy on the right side.

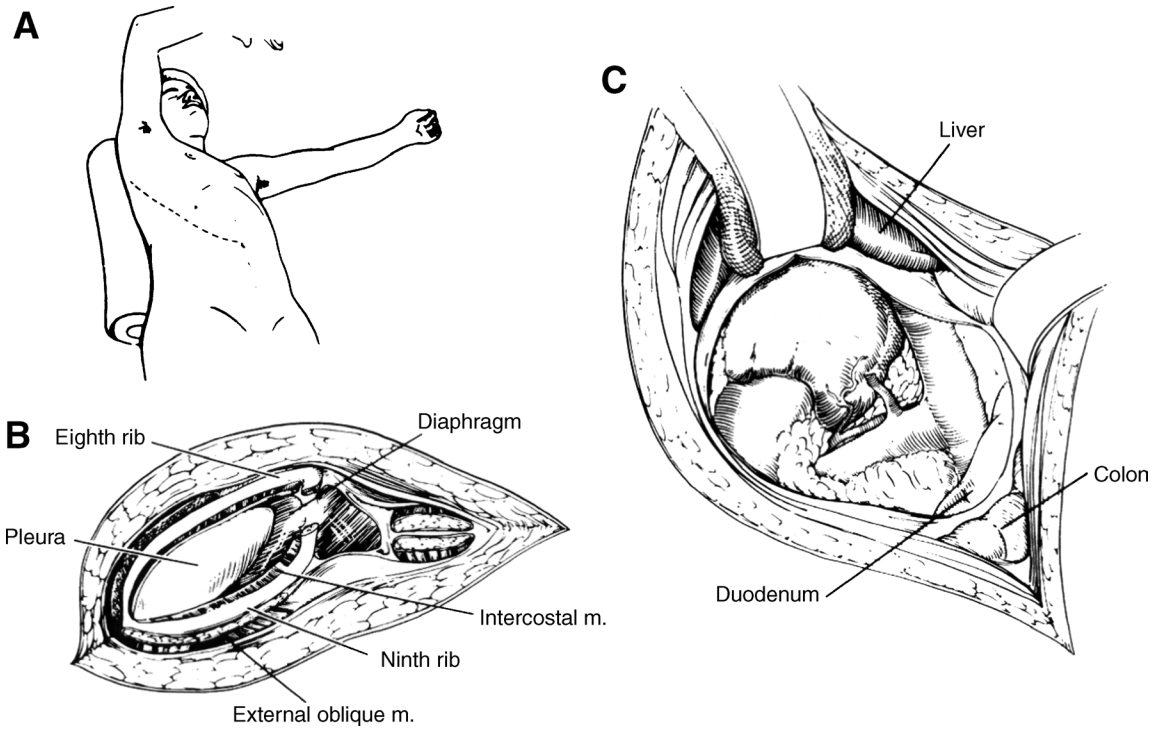

Fig. 2.6

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

ninth intercostal space near the angle of the rib and is carried medially across the umbilicus. The intercostal muscles are divided to reveal the pleura and diaphragm; the diaphragm is divided circumferentially. On the right side, the hepatic flexure of the colon and duodenum are reflected medially and the liver is retracted upward to expose the adrenal tumor. On the left side, the descending colon is reflected medially with superior retraction of the pancreas and spleen to expose the adrenal gland. The details of adrenalectomy or nephroadrenalectomy are the same as those described for the anterior transabdominal surgical approach.

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