TUMORS of the PANCREAS

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With 27 Contributors

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Tumors of the Pancreas

This book is dedicated to my parents,
Yacoob and Maude Moossa,
who sacrificed a lot for my education

FOREWORD

During the last half century, views of surgeons on the treatment of patients with cancer of the pancreas have pursued an interesting, if at times unsatisfying, course.

Fifty years ago, apart from a few isolated and usually spectacularly unsuccessful attempts at resection, it was automatically assumed that a pancreatic cancer was an inoperable lesion and that all that could be done for a patient with such a lesion was to relieve the biliary tract obstruction, usually by means of a cholecystojejunostomy.

Thirty years ago, resection was the aim of almost every exploration of the abdomen for a cancer of the head of the pancreas or periampullary region, a change in philosophy brought about by the pioneer work of Alan Whipple in the late 1930s. Two assumptions were widely made at the time: first, that the so-called "Whipple operation" was technically within the compass of every abdominal surgeon and could be generally performed with an acceptably low mortality; second, that after radical excision of the head of the pancreas and duodenum, the long term results would show a marked improvement upon previous results and that a significant percentage of cures would follow. Both of these assumptions soon proved to be completely unjustified. Indeed, the disillusionment that followed was all the more pronounced because of the high hopes that had been raised and this led many surgeons to abandon resection altogether, complaining that "the mortality of the operation is too high and even if the patients survive, the outlook is very little better than that after a palliative biliary short-circuit." Of course this "very little better" included the only possibility of cure, even if this were, on statistical grounds, unlikely.

The last two decades have seen remarkable changes in the investigation and management of pancreatic cancer. Diagnosis has altered out of all recognition with the introduction of a number of sophisticated aids. Adjuvants to surgery, such as the use of chemotherapy and radiotherapy, separately or in combination, receive increasing study and clearly play some part in treatment. A reassessment of surgical technique had led some to conclude that a much more radical extirpation than has hitherto been practiced may yield improved results. Serological monitoring has introduced a new dimension in assessment and prognosis.

So many new aids of one kind or another have been introduced that the physician who would wish to become involved in the treatment of pancreatic cancer at the present time could be forgiven for feeling confused by the very multiplicity of "advances" which thrust themselves upon him and might well take his eye off the main question—How does all this help to treat patients more successfully?

This book is timely. It presents an admirable blend of the scientific and the clinical and is complete without being over-complicated. Above all it is readable and logical and never loses sight of the central issue, the treatment of patients. Both as a book of reference and as a practical guide to surgeons, it is a splendid addition to medical literature.

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PREFACE

The present decade has witnessed major advances in methods of investigating the pancreas which have created an impact on the classification, diagnosis, and treatment of various pancreatic tumors. This book is an attempt to synthesize and clarify the relevant data in this rapidly growing and specialized field. Although the material is substantially from my own pen, based on my personal experience, I have solicited the help of committed experts in various disciplines where I do not feel competent to write. This book would have never been completed without their diligence and willingness to contribute.

The major problem with surgery of the pancreas is, in my opinion, failure of the surgeon to appreciate fully the anatomy of the pancreas and its related blood vessels. I have purposedly gone into all relevant anatomic details to help the surgeon appreciate the important variations in surgical landmarks. Similarly, an up-to-date account of the physiology of the endocrine and exocrine pancreas is included because it forms the basis of recent concepts in the diagnosis and treatment of pancreatic tumors.

I owe a heavy debt of gratitude to numerous colleagues and friends for their guidance and help during the formative years of my career. My four mentors, Lord Smith of Marlow, Professor George E. Block, Professor David A. Price Evans, and Professor David B. Skinner should be singled out for their influence on my investigative and surgical approaches to the pancreas. Most of the diagnostic work described has been largely developed by investigators at the University of Chicago, the Mayo Clinic, and the Memorial Sloan-Kettering Institute and would not have been performed without the leadership and support of the late Dr. William Pomerance of the National Cancer Institute. Many of the present and past members of my team deserve special recognition: J. Clark, M. J. Cooper, J. Dhorajiwala, F. H. Gelder, A. W. Hall, T. J. Hall, R. G. Hughes, M. H. Lewis, C. R. Mackie, and R. A. B. Wood. Their enthusiasm and investigative spirit have been a constant source of the intellectual stimulus to me.

Numerous students, residents, and colleagues have contributed to this work by their constructive criticisms, by referring patients to me, and by their devotion to the care of my patients. The editors, especially Toni Tracy and Susan Vitale, have been most helpful to me and have exhibited a high degree of tolerance in the production of this volume. My secretary, Maureen Kill, and my chief technician, Silas Brown, should be thanked for their untiring efforts, their good humor, and their constant support.

A large number of illustrations were made especially for this volume by the Audio-Visual Department of the University of Chicago. Several colleagues, other authors, journals, and publishers have generously allowed me to reproduce some of their illustrations. It is my hope that this volume will provide a reliable up-to-date guide to surgeons, internists, and other investigators interested in tumors of the pancreas. If this book, inadequate for its task though it now appears, stimulates investigators from various disciplines to enter this field, where so much remains to be clarified, I will be well rewarded for my labors.

Finally, I owe a lot to my wife Denise and my son Pierre for their sacrifice and encouragement.

ARM
Chicago, 1980

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CHAPTER 1

Surgical Anatomy of the Pancreas

C. R. Mackie and A. R. Moossa

"The pancreas cuddles the left kidney, tickles the spleen, hugs the duodenum, cradles the aorta, opposes the inferior vena cava, dallies with the right renal pedicle, hides behind the posterior parietal peritoneum of the lesser sac, and wraps itself around the superior mesenteric vessels."

H. Derman: Measurements of Exocrine and Endocrine Functions of the Pancreas, edited by F. W. Sunderman and F. W. Sunderman, Jr., J. B. Lippincott Co., Philadelphia, 1961.

GROSS ANATOMY AND RELATIONS

The pancreas is a soft, lobulated gland 12 to 20 cm long which lies transversely in the retroperitoneum of the upper abdomen and extends from the lesser curvature of the duodenum to the hilum of the spleen (Fig. 1.1). The HEAD of the pancreas lies within the C-shaped concavity of the duodenum. It is intimately related to the lesser curvature of the second part of the duodenum and the upper aspect of the third part. Superiorly the head is related to the peritoneum of the inferior border of the gastroepiploic foramen and the structures which form the contents of the free border of the lesser omentum. Anteriorly, the first part of the duodenum covers the superior part of the pancreatic head, and, below this, the right side of the transverse mesocolon is attached transversely from duodenum to the root of the small bowel mesentery. The head of the pancreas lies anterior to the inferior vena cava and *both* renal veins. The common bile duct leaves the free border of the lesser omentum to pass behind the upper border of the head of the pancreas. It grooves the posterior aspect of the head of the gland before turning anteriorly to the right, passing through the substance of the head to reach the duodenal papilla. From the posterior aspect of the inferior part of the head, a tongue of pancreatic tissue, the UNCINATE PROCESS, extends to the left and posteriorly to occupy the concavity formed by the third and fourth parts of the duodenum. It lies in the groove between the inferior vena cava and the aorta and is covered superiorly and anteriorly by the superior mesenteric vessels as they emerge below the neck of the pancreas.

The constricted part of the pancreas forming the junction of the head and body of the gland, called the NECK of the pancreas, is 3 to 4 cm in width. It lies behind the posterior peritoneum of the lesser sac, its inferior border being covered by the attachments of the transverse mesocolon and the upper limit of the root of the small bowel mesentery. The neck of the pancreas may be defined as the part that covers and is intimately related to the superior mesenteric vein, the confluence of the superior mesenteric and splenic veins, and the first part of the portal vein.

In the midline, the BODY of the pancreas, obscured from view by the antrum of the stomach, is held securely against the aorta by the posterior peritoneum of the lesser sac. Here the left renal vein, passing between aorta and pancreas, is separated from the latter by the first part of the superior mesenteric artery. At a slightly higher level, elements of the celiac and superior mesenteric plexus ramify between pancreas and aorta. This midline part of the body of the pancreas, pushed anteriorly by the bodies of the first and second lumbar vertebrae, lies most closely to the anterior abdominal wall. Because of its fixity and prominence here, a

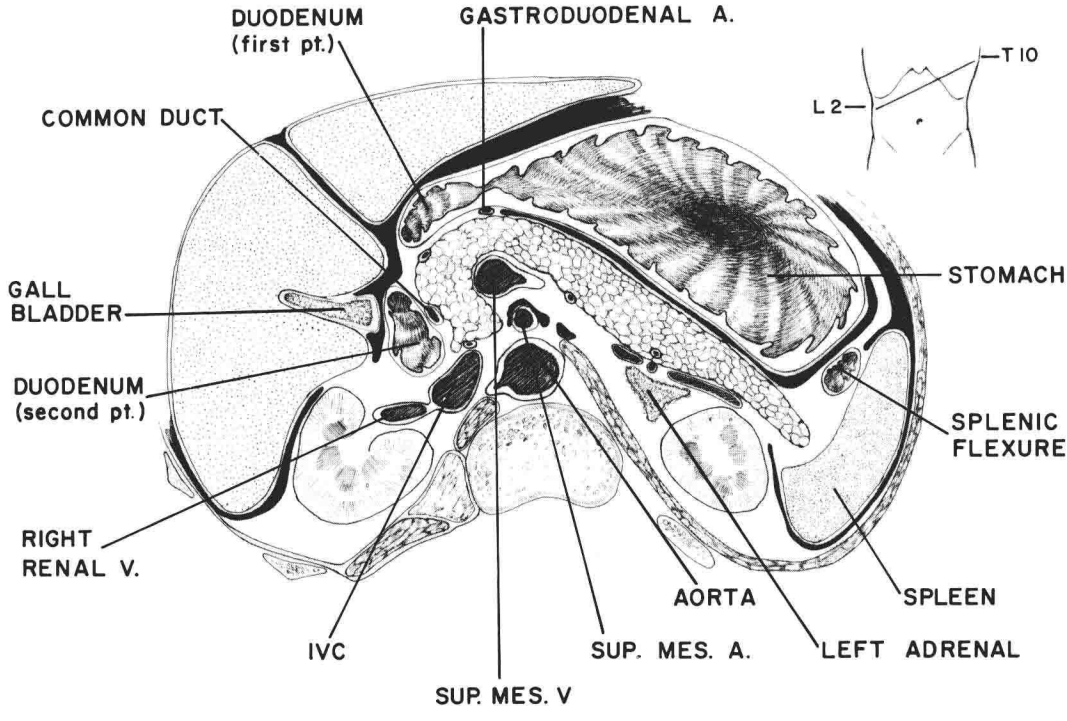

Figure 1.1 Oblique transverse cross section of the upper abdomen viewed from below. Section passes through the long axis of the pancreas at approximately the level indicated in the inset figure. The disposition and relations of structures shown approximate those seen on oblique transverse ultrasonic scanning.

tumor may be palpated as a mass that does not move with respiration and that strongly transmits the aortic pulsation. Between the superior border of the pancreas and the decussation of the crura of the diaphragm, the celiac axis, surrounded by the celiac plexus, divides into its major branches.

To the left, the body and TAIL of the pancreas pass laterally, posteriorly, and slightly cephalad behind the posterior peritoneum of the lesser sac, overlying successively the posterior attachments of the left diaphragm, the left adrenal gland, the left kidney, and the hilum of the spleen. The splenic vein above and the left renal vein below lie close to one another behind the body of the pancreas. At the upper border of the body and tail of the pancreas, the splenic artery courses laterally to the left. The transverse mesocolon is attached to the anterior part of the lower border of the gland. The splenocolic ligament attaches the splenic flexure of the colon to the hilum of the spleen, in close relation to the tail of the pancreas. Figure 1.2 summarizes the major posterior relations of the pancreas.

Kreel et al. (19) have studied the variations of shape and disposition of the pancreas by obtaining *in situ* postmortem pancreatograms. The typical oblique lie occurred in 37% of the preparations, with an L-shaped pancreas, having the head and neck aligned infero-superiorly and the body and tail transversely, being the commonest variation (34% of individuals).

In other cases, the pancreas was described as being sigmoid (17%), inverted—U—shaped (8%), transverse (3%), or inverted—V—shaped (1%). The bulk of the head of the gland was usually to the right of the spine (57% of individuals), in some cases was found to be directly overlying the spine (38%), but rarely (5%) to the left of the spine. These authors also noted a tendency of the head of the pancreas to be ptotic in some elderly individuals. In the majority of preparations

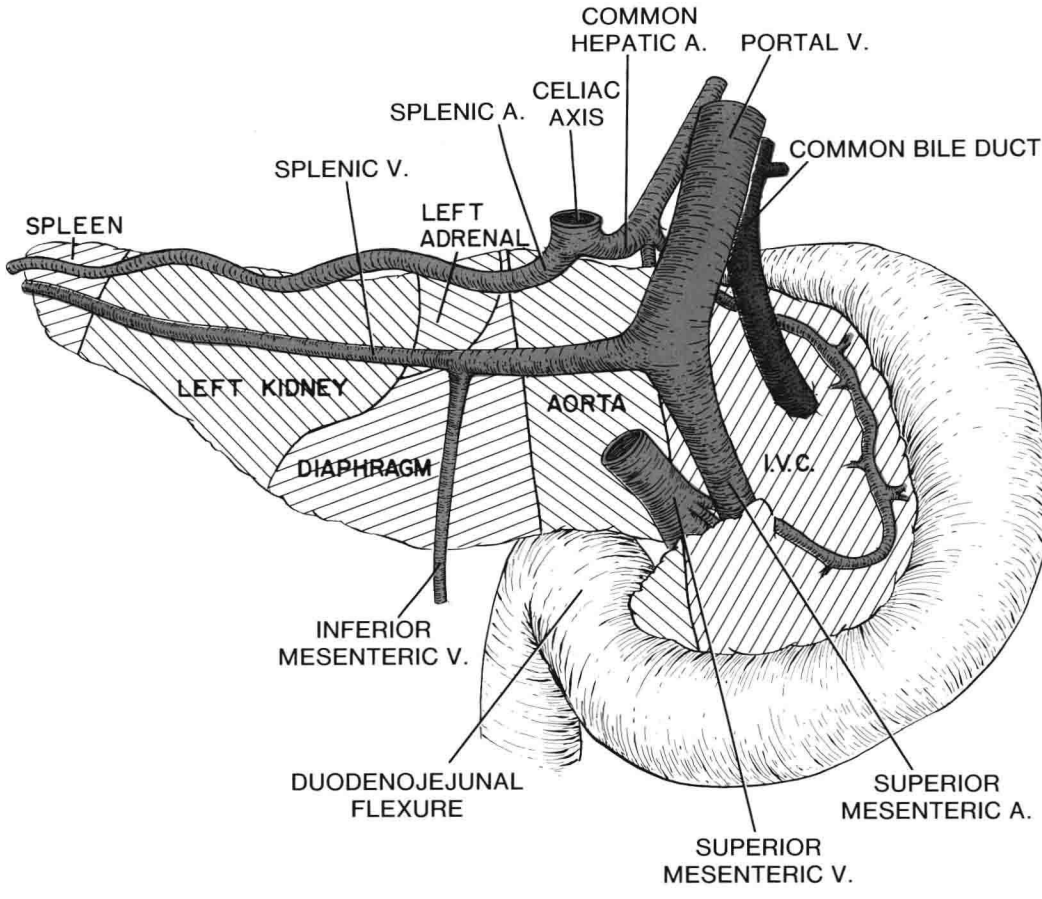

Figure 1.2 The pancreas and duodenum viewed from their posterior aspect. The major posterior relations of the pancreas are indicated.

(92%) the duodenal opening of the main pancreatic duct was between the levels of L2 and L4, but in one case it was found as low as S2.

OPERATIVE APPROACHES

Without some dissection, very little of the pancreas can be seen or directly felt at laparotomy. In a thin patient, small areas of the head of the gland may be seen directly behind the peritoneum of the supracolic and right infracolic compartments, and the inferior border of the body and tail may be seen from the left infracolic compartment at the root of the transverse mesocolon. However, these limited views are usually obscured by omental and mesocolic fat. The neck of the pancreas may be felt by a finger passed through the gastroepiploic foramen.

The head of the pancreas may be inspected and palpated by performing two simple maneuvers. First, the hepatic flexure of the colon is mobilized downwards and medially, dividing the attachment of the transverse mesocolon to the duodenum and pancreatic head as far as the middle colic vessels. Second (Kocher maneuver), the peritoneum lateral to the second part of the duodenum is incised; the duodenum and pancreatic head may then be swept to the left, exposing the right renal vein, the inferior vena cava, the root of the left renal vein, and the retroduodenal and pancreatic portions of the common bile duct. Following these maneuvers, the head of the pancreas may be palpated anteroposteriorly between thumb and fingers. The mesenteric

vessels are obscured from view by the uncinate process.

Limited visualization of the superior part of the body of the pancreas may be obtained by opening an avascular part of the lesser omentum and retracting the lesser curvature of the stomach inferiorly. This maneuver also brings the celiac axis into view. A similarly limited exposure of the body of the pancreas may be obtained by opening into the lesser sac from below through an avascular part of the left transverse mesocolon. A much more adequate visualization of the body of the pancreas may be obtained by widely opening the lesser sac by dividing the gastrocolic omentum along the greater curvature of the stomach (Fig. 1.3). Extending this opening to the right, into the subpyloric region with division of the right gastroepiploic vessels, will allow visualization of the anterior aspect of the neck of the pancreas; in this area, care must be taken to avoid damage to the middle colic vessels. Extending the opening to the left and dividing the gastrosplenic ligament with its contained short gastric vessels above and the vascular splenocolic ligament below will permit complete visualization of the anterior surface of the tail of the pancreas. The inferior border of the body and tail may now be brought into view by dividing the superior leaf of the attached transverse mesocolon. Downward and medial retraction of the spleen will expose and tense the lienorenal ligament. If this is divided, the spleen, splenic vessels, and pancreas may be mobilized medially en bloc, allowing inspection of the

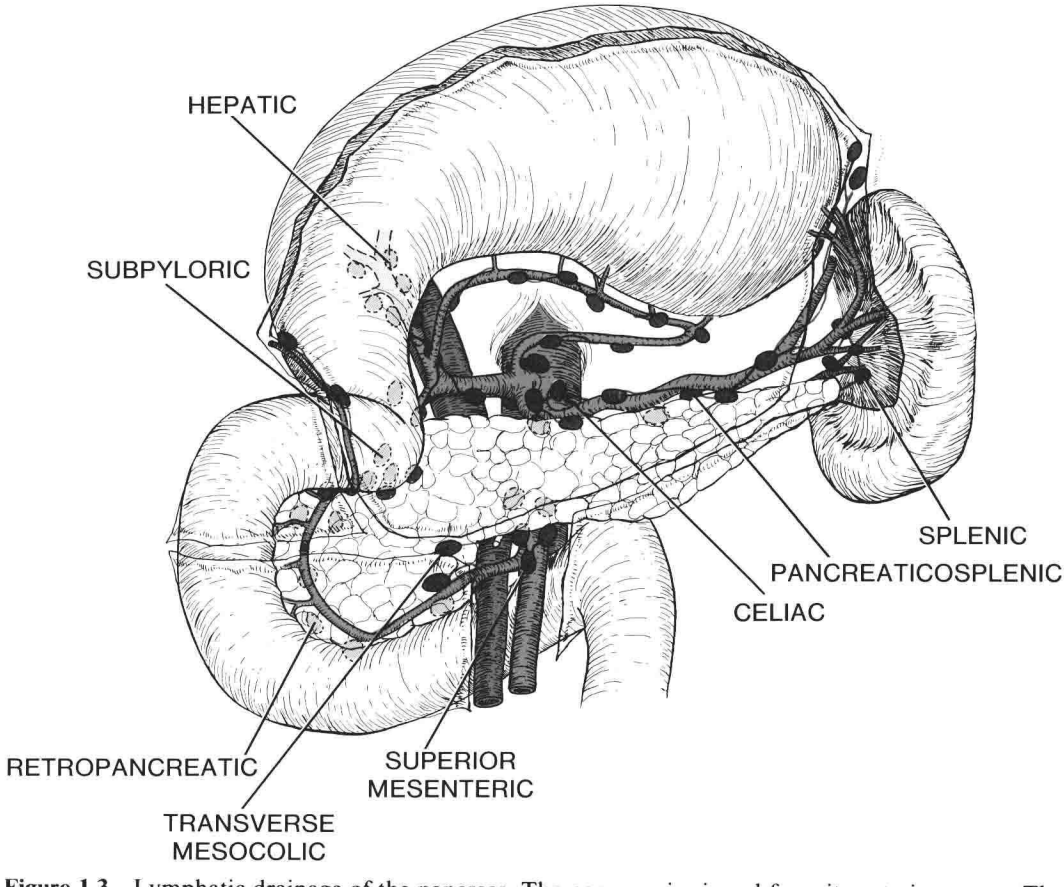

Figure 1.3 Lymphatic drainage of the pancreas. The pancreas is viewed from its anterior aspect. The gastrocolic ligament has been divided along the greater curvature of the stomach, which has been retracted anterosuperiorly. The transverse mesocolon has been detached from the peritoneum of the posterior abdominal wall. Labels indicate representative lymph nodes in the major regional nodal groups.

posterior aspect of the tail and body of the pancreas and more careful palpation.

All these maneuvers may be carried out quickly and safely, with little risk of damage to vital structures or troublesome bleeding. By these means, all except the region of the neck and uncinate process of the pancreas may be fully evaluated. However, further dissection and mobilization may be needed to assess the resectability of a tumor. For this, a detailed knowledge of the pancreatic and the peripancreatic vasculature and its variations is required.

ARTERIES (Fig. 1.4)

The pancreas derives its blood supply from the celiac axis and the superior mesenteric artery. Since these major vessels and their branches to organs other than the pancreas are encountered in pancreatic surgery, they will be described in some detail.

Typically (in 89% of individuals), the celiac axis divides into the common hepatic, splenic, and left gastric arteries (21). Up to 15 types of celiac axis branching have been described (11); the more important variations are shown in Figure 1.5. The common hepatic artery passes to the right, anterior to the portal vein, to gain the free border of the lesser omentum. In doing so, *it may take an upward, horizontal, or downward direction, the latter variation bringing it into contact with the upper border, or even the posterior aspect, of the head of the pancreas.* There is some evidence that the direction of the common hepatic artery is reflected by the subcostal angle, a more acute angle being associated with a downward

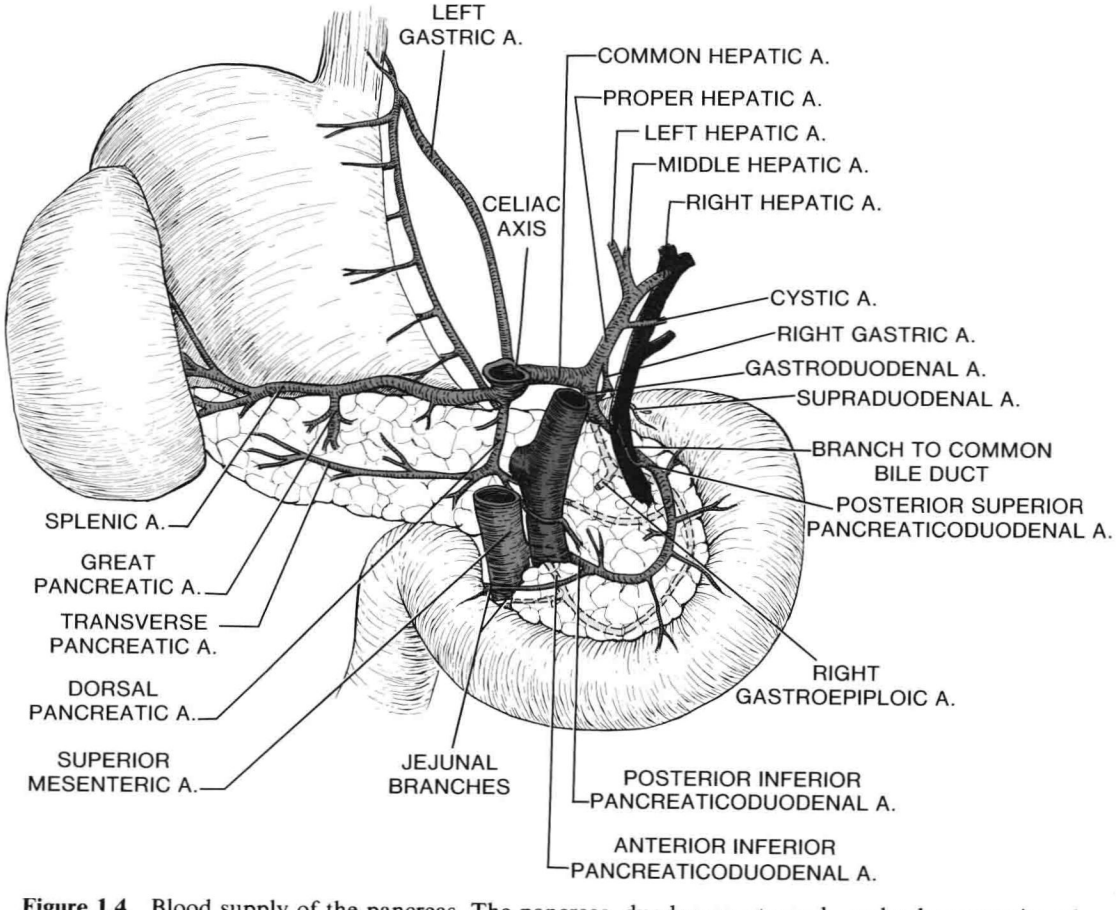

Figure 1.4 Blood supply of the pancreas. The pancreas, duodenum, stomach, and spleen are viewed from their posterior aspects.

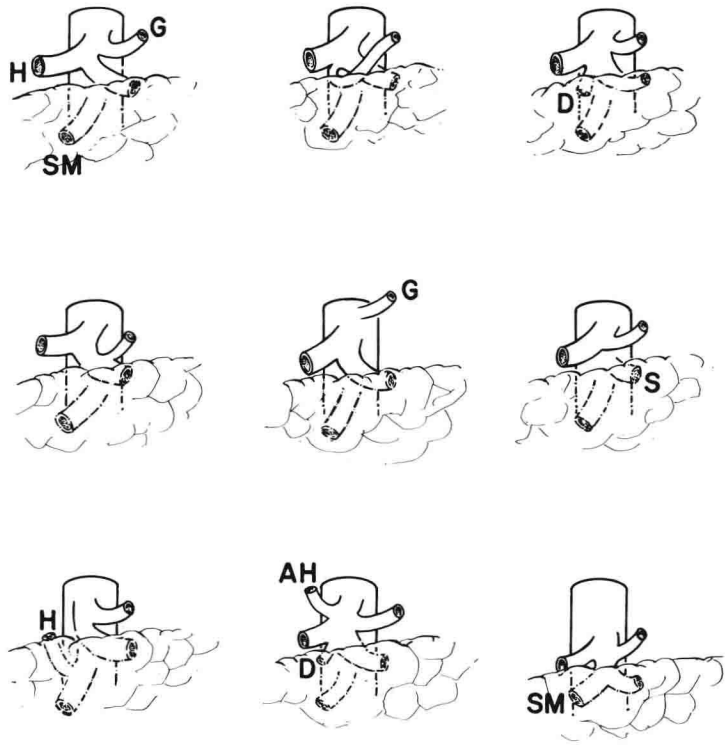

Figure 1.5 Some of the more common celiac axis variations. Top left diagram represents the commonest arrangement of major vessels. Bottom left represents a surgically important variation, having the common hepatic artery replaced by a branch from the superior mesenteric artery. One or both phrenic arteries (not shown) frequently arise from the celiac axis. *H*, hepatic; *G*, left gastric; *S*, splenic; *SM*, superior mesenteric; *D*, dorsal pancreatic; *AH*, accessory hepatic artery. [Adapted from Hollinshead (17).]

course of the vessel (24). After giving off the gastroduodenal artery, the hepatic artery turns upwards towards the porta hepatis and divides into left and right hepatic arteries, the middle hepatic artery, supplying the caudate lobe, being a branch of either of these. Michels (21) has found that this *typical arrangement of the hepatic blood supply occurs in only 55% of individuals.* Since replaced or "accessory" hepatic arteries are frequent and more likely to be damaged in the course of a pancreatic resection (4), and since such damage is liable to be associated with fatal postoperative hepatic infarction (20), a detailed consideration of hepatic artery variations is necessary. Table 1.1 summarizes the 10 types of derivation of hepatic arterial blood supply identified by Michels (21) in 200 cadaveric dissections. It should be pointed out that second right or left hepatic arteries, frequently called "accessory" vessels, have been shown to supply parts of the liver not served by other vessels (14) and are, therefore, not truly accessory.

After giving off the gastroduodenal artery, the hepatic artery may give origin to the supraduodenal artery, a small vessel of variable origin (Fig. 1.6) that supplies the first part of the duodenum. Above this, the right gastric artery arises from the proper hepatic artery or from the left hepatic artery with similar frequencies (21). Less often this vessel is a branch of the gastroduodenal artery. It is important to remember that when the right hepatic artery arises from the superior mesenteric artery, it may give rise to the inferior pancreaticoduodenal artery, the dorsal pancreatic artery, and/or the gastroduodenal artery as it ascends behind the head of the pancreas, making a tedious dissection necessary for its preservation in the course of a pancreatic resection.