extremely poor teaching of this discipline of basic science in the United States, and perhaps all over the world.

Arterial Blood Supply (by Bertelli and Colleagues)

The arterial blood supply of the pancreas is provided mainly by the celiac and superior mesenteric arteries. From these arteries and/or from their major branches, eight main arteries arise with various patterns of origin and supply the pancreas:

- PSPD: posterior superior pancreaticoduodenal artery
- ASPD: anterior superior pancreaticoduodenal artery
- AIPD: anterior inferior pancreaticoduodenal artery
- PIPD: posterior inferior pancreaticoduodenal artery
- DP: dorsal pancreatic artery
- PM: pancreatica magna artery
- TP: transverse pancreatic artery
- CP: caudal pancreatic artery

The most common arrangements of these arteries are illustrated in Fig. 21-40. Many other arrangements are possible due to the variations in number, incidence, sites of origin and, sometimes, even course of pancreatic arteries. This marked irregularity, particularly in the distal segment of the pancreas (body/tail), leads to difficulty in interpreting the patterns of arterial vascularization and to strikingly divergent statistical analyses.

In this overview, we cite almost all the statistical surveys available in the anatomic literature (except that from "in vivo" angiographic studies) since, at the moment, it is impossible to ascertain which, among them, has been compiled most correctly. Our purpose is not to generate fruitless doubts in the reader's mind. On the contrary, we wish to strongly emphasize how tricky it is to delineate the pancreatic arterial network. It is doubtful that any definite anatomic conclusion can be drawn yet.

We present a detailed portrait of each artery involved in the blood supply of the pancreas. We will follow topographic criteria in our exposition, dividing the description into three parts corresponding to the head, the neck/ body, and the tail of the pancreas.

Head of the Pancreas (Figs. 21-40, 21-41)

The head of the pancreas receives blood mainly from the hepatic artery, via the gastroduodenal artery, and from the superior mesenteric artery via the inferior pancreaticoduodenal (IPD) artery. The gastroduodenal artery supplies the PSPD and the ASPD arteries to the head of the pancreas, sometimes through a common superior pancreaticoduodenal (SPD) artery. The IPD artery divides into the PIPD and the AIPD arteries which, anastomosing with the two SPD arteries, form two pancreaticoduodenal (PD) arcades, namely the anterior and the posterior PD arcades.

A detailed description of this complex of PD arteries and their frequent variations can be found in a series of recent articles.[93,94,95,96,112] Here, we will summarize some notions of major interest to the surgeon.

Posterior Superior Pancreaticoduodenal (PSPD) Artery. The PSPD artery has been previously referred to as the retroduodenal artery.[113-116] This name can cause confusion, since "retroduodenal" has also been used for a distinct group of small arteries that arise a little above the terminal division of the gastroduodenal artery to supply the first and second portions of the duodenum.[117-120]

The PSPD artery is considered a constant.[98,121,122,123] In some cases, its calibre is so small as to be hardly detectable by routine angiography. The PSPD artery can also be as large as 3 mm.[115,121,123]

In about 70-80% of cases the PSPD artery arises within the first 2 cm of the gastroduodenal artery,[121,124,125] usually from its posterior aspect, as the first collateral branch. In general, the PSPD artery has a spiral, descending course

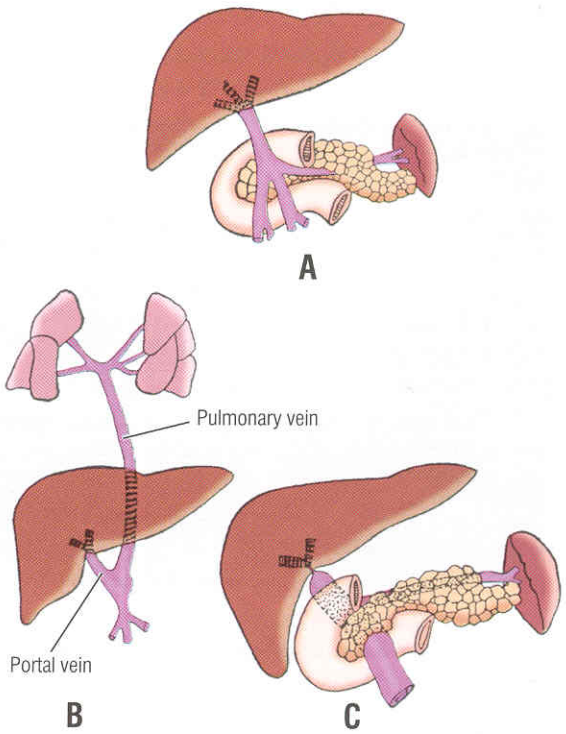

Fig. 21-39. Anomalies of portal vein. **A,** Vein and its tributaries lie anterior to pancreas and duodenum. **B,** Pulmonary vein joins portal vein. **C,** Congenital stricture of portal vein. (Modified from Mc Gregor AL, Du Plessis DJ. A Synopsis of Surgical Anatomy (10th ed). Baltimore: Williams & Wilkins, 1969; with permission.)

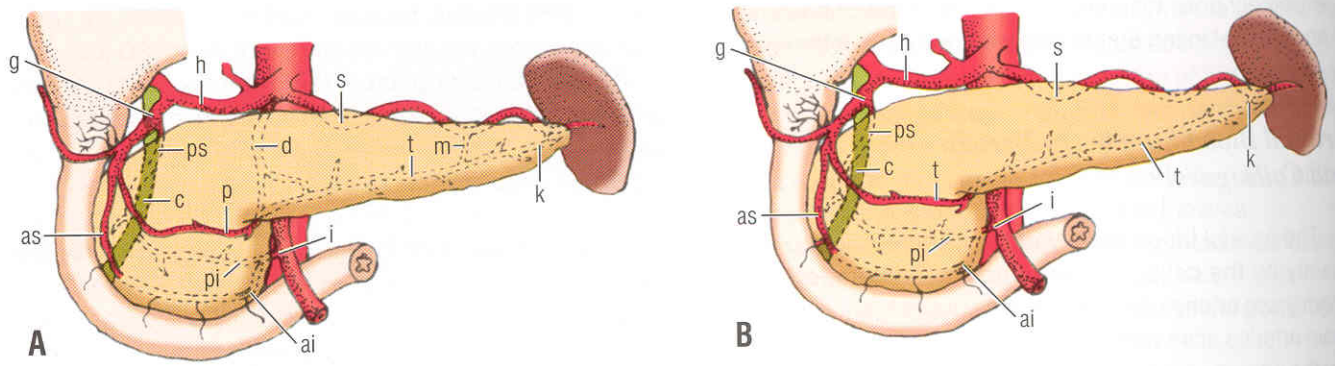

FIG. 21-40. Most common patterns of pancreatic arterial blood supply. h, common hepatic artery; g, gastroduodenal artery; s, splenic artery; as, anterior superior pancreaticoduodenal (ASPD) artery; ps, posterior superior pancreaticoduodenal (PSPD) artery; pi, posterior inferior pancreaticoduodenal (PIPD) artery; ai, anterior inferior pancreaticoduodenal (AIPD) artery; d, dorsal pancreatic (DP) artery; p, prepancreatic arcade; t, transverse pancreatic (TP) artery ("short type" in **A**, "long-type" in **B**); m, pancreatica magna (PM) artery; k, caudal pancreatic (CP) artery; c, choledochus; i, inferior pancreaticoduodenal artery. (Courtesy Dr. Eugenio Bertelli.)

that surrounds the choledochus: it runs transversely from left to right in front of the CBD, turns around its right lateral side, then again crosses the choledochus, from right to left (this time posteriorly), to anastomose with the PIPD artery. Several variations can occur, especially when the artery arises from other sources.

The PSPD artery can arise, in more than 20% of cases, from "non-conventional" sources, mainly the hepatic artery or its branches, regardless of their origin. These sites and the frequency of their occurrence have been noted by various investigators:

- common hepatic artery (3%)[115,125,126]
- right hepatic artery (2-3%)[114,121,122,125]
- an accessory right hepatic artery stemming from the

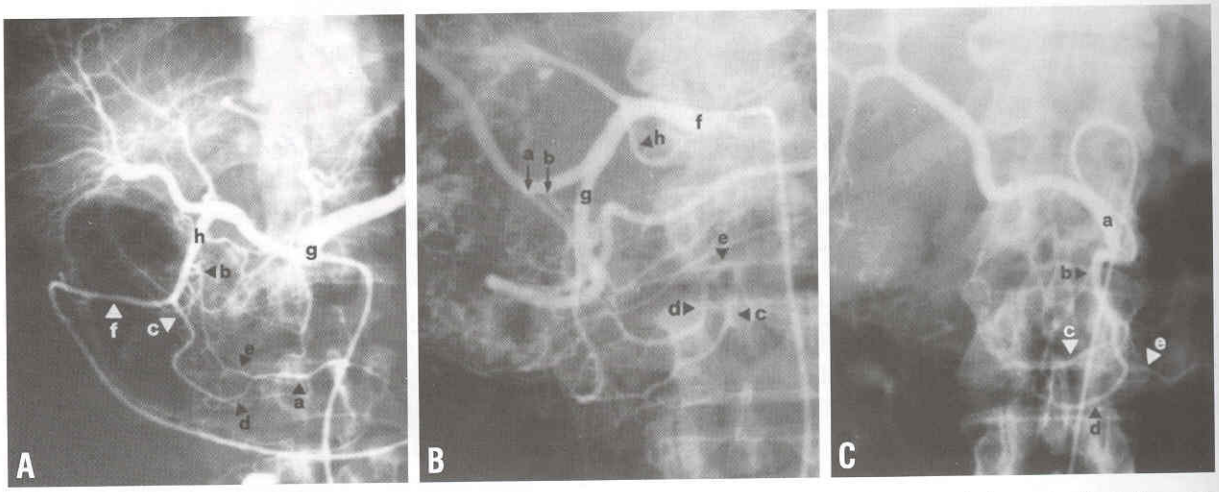

Fig 21-41. Arterial blood supply of pancreatic head. **A,** Selective angiography of celiac trunk **(g)** (anteroposterior projection). Frequent pattern of arterial vascularization: two SPD arteries arise from gastroduodenal artery **(h)**. Two IPD arteries originate from division of common IPD artery **(a).** PSPD artery **(b)**; ASPD artery **(c)**; AIPD artery **(d)**; PIPD artery **(e)**; right gastroepiploic artery **(f)**. **B,** Selective angiography of common hepatic artery **(f)** (anteroposterior projection). Rare variation of origin of SPD arteries which stem separately from the right hepatic artery. PSPD artery **(a)**; ASPD artery **(b)**; AIPD artery **(c)**; PIPD artery **(d)**; IPD artery **(e)**; right gastroepiploic artery **(g)**; right gastric artery **(h)**. **C,** Selective angiography of accessory right hepatic artery arising from superior mesenteric artery **(a)** (anteroposterior projection). Variation of origin of two IPD arteries. The AIPD **(d)** and PIPD **(c)** arteries originate separately from common trunk **(b)** with jejunal artery **(e)**. SPD, superior pancreaticoduodenal; IPD, inferior pancreaticoduodenal; PSPD, posterior superior pancreaticoduodenal; ASPD, anterior superior pancreaticoduodenal; AIPD, anterior inferior pancreaticoduodenal; PIPD, posterior inferior pancreaticoduodenal; IPD, inferior pancreaticoduodenal. (Courtesy Dr. Eugenio Bertelli.)

superior mesenteric artery (3-8%)[94,113,114,125,126,127]
- common hepatic artery arising from the superior mesenteric artery (3%)[125]
- proper hepatic artery (2-8%)[94,121,124]
- superior mesenteric artery (3-5%)[94,125]
- SPD artery (5-7%)[93,124,125]
- DP artery (1%)[114]
- left hepatic artery (infrequent)[94,128]

Among the many possible collateral branches of the PSPD artery, we recall those of surgical interest:
- cystic artery (1%)[115]
- superficial cystic artery (3%)[115]
- right gastric artery (1%)[114]
- retroduodenal artery[117,120]
- accessory right hepatic artery[115,128]

Anterior Superior Pancreaticoduodenal (ASPD) Artery. The ASPD artery is an almost constant artery,[119,129] usually larger than the PSPD artery. In more than 90% of cases it arises from the gastroduodenal artery[122,124] as one of its terminal branches, behind the inferior edge of the first duodenal portion. In almost all other cases (5-7%) the ASPD artery originates from the SPD artery,[93,124,125] or exceptionally from other sources.[93,116,121,122]

Running downward, the ASPD artery can lie either in front of the duodenum or on the surface of the pancreatic head.[130] Sometimes it is buried in the parenchyma of the gland.[118] At the level of the duodenal papilla, the artery occasionally can be separated from the choledochus by only 1 mm of pancreatic parenchyma.[130] Upon reaching the lower flexure of the duodenum, the ASPD artery usually turns backward and courses over the posterior surface of the uncinate process,[115,118,122,125,127,131] where it anastomoses with the AIPD artery. In a minority of cases, the artery may remain on the anterior aspect of Winslow's process.[117,118,122]

Some collateral branches of surgical interest have been sporadically reported:
- TP artery (8-10%)[93,126,127]
- retroduodenal artery[93,120]
- cystic artery[121]
- right root of the prepancreatic arcade (see below)

Inferior Pancreaticoduodenal (IPD) Artery. The AIPD and the PIPD arteries originate from the bifurcation of the IPD artery in 60-70% of cases.[115,119]

The IPD artery arises directly from the superior mesenteric artery[95] as its first right collateral branch. When an accessory right hepatic artery is present, the IPD artery is the second right collateral branch.[123] The incidence of such a pattern of origin has not been clearly determined; it has been reported as ranging from 4% to 47% of cases, depending on the authors.[121,124,125,126,132,133]

The level at which the IPD artery arises from the superior mesenteric artery is variable, corresponding more frequently to the inferior edge of the neck of the pancreas.[118,121] An origin behind the pancreas is not uncommon.[95,118,119]

In other cases, the IPD artery arises through a common trunk with the first jejunal artery.[95] This trunk is referred to as the pancreaticoduodenojejunal (PDJ) trunk. Its occurrence has been reported in about 20% to 64% of cases.[121,124,125,126,132,133,134] Any statistical analysis could be affected by the interpretation that each investigator gave to the name "PDJ trunk." According to these authors, in fact, the term "PDJ trunk" could also refer to the common trunks composed of the first jejunal artery and just one of the IPD arteries, or by the first jejunal artery and both IPD arteries stemming without forming a common IPD artery.

Less frequent sites of origin for the IPD artery:
- accessory right hepatic artery arising from the superior mesenteric artery (1%)[95,98,115,123]
- through a common trunk with the DP artery (6-8%)[98,121,125]
- through a common trunk with the 2nd jejunal artery (2%)[125]
- through a common trunk with the first 2 or 3 jejunal arteries[95,117]
- middle colic artery[115,119]

The course of the first portion of the IPD artery varies according to the site of origin. It runs downward when arising behind the pancreas. When arising through common trunks with the jejunal arteries, it goes transversely from left to right, crossing the superior mesenteric artery posteriorly.[98,117,126,133] Regardless of its origination, the IPD artery crosses behind the superior mesenteric vein and is in contact with the posterior face of the uncinate process,[121] where it divides into the AIPD and the PIPD arteries.

Some important collateral branches of the IPD artery can be:
- jejunal arteries[121,123,133]
- right gastroepiploic artery[115]
- an anastomotic branch with the first jejunal artery[116]

Anterior Inferior Pancreaticoduodenal (AIPD) Artery. The AIPD artery is usually the smallest of the PD arteries.[133,135] It is almost always constant.[124]

In the majority of cases, the AIPD artery arises from the division of the IPD artery. Alternate sources are common:
- a common trunk with the first jejunal and the PIPD arteries (do not confuse with the PDJ trunk) (17-30%)[96,122,132,134]
- first jejunal artery (5-30%)[96,121,122,124,126,132,133]
- superior mesenteric artery (5-16%)[96,122,124,126,127,133]
- second jejunal artery (2-6%)[121,133]
- DP artery (infrequent)[126]

- an accessory right hepatic artery (infrequent)[121,126]
- middle colic artery (infrequent)[121]

When arising from a site situated on the left of the superior mesenteric artery, the AIPD artery crosses the superior mesenteric vessels posteriorly. The AIPD artery usually runs behind the uncinate process,[122] but it may be prepancreatic,[122,133] subpancreatic,[133] or even intrapancreatic.[133] In 90% of cases, it ends by anastomosing with the ASPD artery.[124]

POSTERIOR INFERIOR PANCREATICODUODENAL (PIPD) ARTERY. The PIPD artery is an almost constant artery which originates mainly from the IPD artery. Less frequently, it arises from:

- a common trunk with the first jejunal artery and the AIPD artery (do not confuse with the PDJ trunk) (17-30%)[96,122,132,133]
- superior mesenteric artery (8-25%)[121,122,124,126,127,132,133]
- first jejunal artery (3-16%)[121,122,124,126,132]
- an accessory right hepatic artery (2-7%)[121,124,126,132,133]
- DP artery (2-8%)[124,126,132]
- a common trunk with the TP artery (rare)[132,133]
- second jejunal artery (rare)[124]

The course of the PIPD artery is generally short. When the PIPD artery arises from the first jejunal artery or from the PDJ trunk, it may be longer, since it has to cross behind the superior mesenteric vessels.[126] On the whole, the PIPD artery has a course parallel to the AIPD artery, which is situated 2-3 cm below.[96]

PREPANCREATIC (KIRK'S) ARCADE. The head of the pancreas is supplied also by the right branch of the DP artery. This branch crosses the anterior surface of the head in an intermediate position. It forms the prepancreatic (Kirk's) arcade,[93,115,126] joining with a small artery coming from the gastroduodenal, right gastroepiploic or, less frequently, ASPD arteries. This arcade has been reported in 75% to 93% of cases.[125,126,135,136]

VARIATIONS. In relation to the head of the pancreas, two major variations of the pattern of arterial vascularization should be remembered:

- DP artery
  - In about 20% of cases, the DP artery may arise from the common hepatic artery. Therefore, its first portion can be found behind the head of the pancreas.
- TP artery
  - The TP artery, usually the left branch of the DP artery, may cross the anterior surface of the pancreatic head in about 30% of cases. It arises from the gastroduodenal,[115,116,126,137] ASPD,[115,118,126,127,137,138] or right gastroepiploic arteries.[114,115,127,138]
  - The TP artery may also arise from an accessory right[94] or proper (Fig. 21-42) hepatic artery coming from the superior mesenteric artery, or from the IPD artery.[137]

REMEMBER: In all these variations, the TP artery, crossing the usual line of Whipple resection, may represent a vascular hazard, especially when it acquires dominance (see below).

Neck and Body of the Pancreas

(Figs. 21-40, 21-42, 21-43)

The neck and body of the pancreas are supplied by 3 to 7 minor branches of the splenic artery,[134] and by the DP, PM, and TP arteries.

DORSAL PANCREATIC (DP) ARTERY. The DP artery was first described by Haller[128] who referred to it as "arteria pancreatica suprema." Subsequently, it has been called by many different names, thus creating confusion. We recall those frequently used:

- "superior pancreatic artery"[118,121,127]
- "middle pancreatic artery"[123,139]
- "isthmic pancreatic artery"[123,134]
- "arteria pancreatica magna"[117,123,124,134,139]
- "arteria colli pancreatis"[125,140]

In the absence of pathological collateral circulations, the DP artery is certainly the largest vessel of the pancreas; its calibre can be as large as 1 cm.[118] The DP artery is present in 80-98% of cases.[98,126,127,139,141,142]

The DP artery may arise from four main sources. Various investigators have found quite different incidences for each pattern of origin:

- first portion of the splenic artery (22-80%)[98,117,123,125,126,127,134,137,139,143]
- celiac trunk (3-33%)[98,117,121,123,125,126,127,134,137,139,143]
- first portion of the common hepatic artery (12-25%)[98,117,123,125,126,127,134,137,139]
- superior mesenteric artery (6-25%)[117,123,125,126,127,137,139,143]

Less frequently reported patterns of origin of the DP artery are from:

- an accessory right hepatic artery arising from the superior mesenteric artery[125,134,137]
- a common trunk with the IPD artery[98,115,121,125]
- gastroduodenal artery[121,125,127,137,144]
- aorta[128,138]
- left inferior phrenic artery[138]
- right gastric artery[134]
- left gastric artery[117,128]
- PSPD artery[127]
- middle colic artery[115,137,138]
- proper hepatic artery[97]

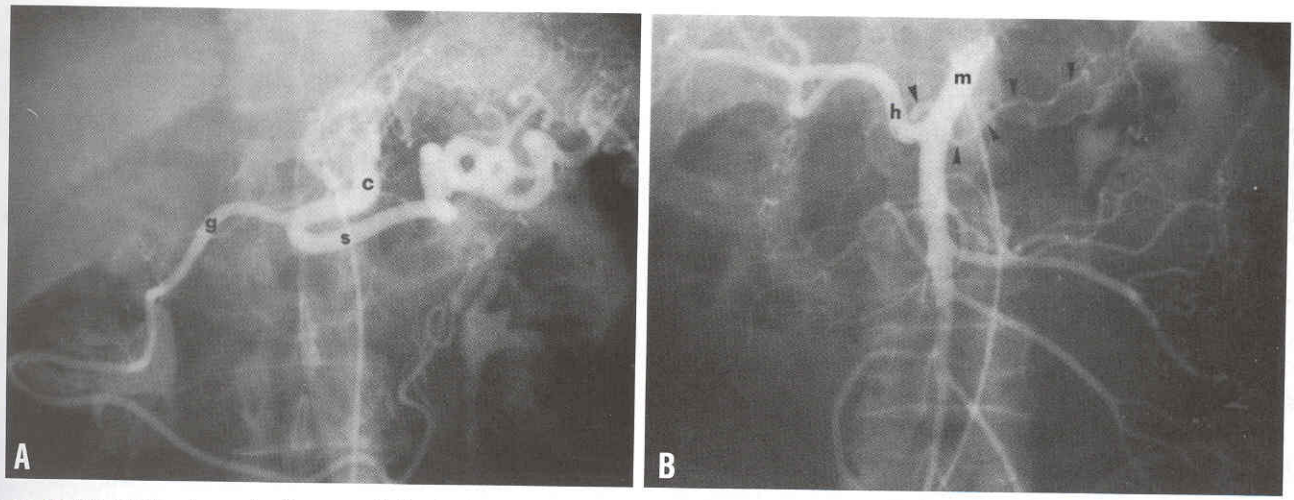

FIG. 21-42. Arterial blood supply of pancreatic body shows patient with dominant "short-type" TP artery. **A,** Selective angiography of **(c)** celiac trunk (anteroposterior projection). Note very limited blood supply to pancreas coming from **(g)** gastroduodenal and **(s)** splenic arteries. **B,** Selective angiography of **(m)** superior mesenteric artery (anteroposterior projection). The **(h)** proper hepatic artery stems from superior mesenteric artery and gives off a large dominant TP artery (arrowheads). TP, transverse pancreatic. (Courtesy Dr. Eugenio Bertelli.)

The course of the DP artery is rather constant since the origin is almost always situated close to the division of the celiac trunk.[117,137] When the DP artery has a high origin (hepatic, celiac, or splenic arteries), it goes downward with a course that slightly bends to the left when arising from the common hepatic artery, or to the right when arising from the splenic artery.[117]

In general, the DP artery, situated on the left of the portal vein, crosses the terminal segment of the splenic vein posteriorly.[101,115,117,118,138] When arising from the superior mesenteric artery, however, the DP artery divides into its terminal branches after a very short course directed upward.[115]

The site of division is rather constant. It is situated close to the lower border of the pancreas, at the junction between the neck and the body, near the corner formed by the splenic and superior mesenteric veins.[117,139]

The DP artery divides as an inverted T into two terminal branches which run transversely in opposite directions.[118,125,126,131,143] The right terminal branch runs behind the superior mesenteric vein[131,139] and forms the prepancreatic arcade[93] (see above); less frequently, it may resolve into minute branches for the ventral surface of the pancreatic head.[131] The left terminal branch of the DP artery is the TP artery (see below).

Some collateral branches of the DP artery have been reported occasionally. We mention those of surgical interest:

- middle colic artery[115,117,118,125,126,137,138]
- accessory right hepatic artery[138,145]
- right colic artery[138]
- left colic artery[98,138,146]
- IPD artery[115]
- PSPD artery[114,115,125,126]
- AIPD artery[124,125,126]
- PIPD artery[96,124,125,126,131,132]
- jejunal arteries[98]

PANCREATIC MAGNA (PM) ARTERY. The PM artery[126,147] is also known as "arteria corporis pancreatis"[125,140] or "great

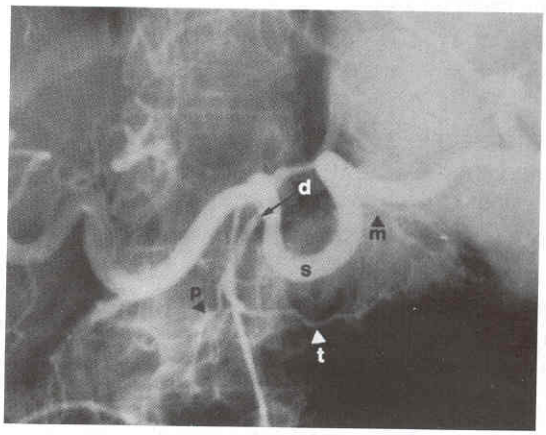

FIG. 21-43. Arterial blood supply of pancreatic body. Selective angiography of celiac trunk (anteroposterior projection). Frequent pattern of arterial vascularization: **(d)**, DP artery takes origin from **(s)** splenic artery soon after arising from celiac artery. DP artery divides into a right branch **(p)** prepancreatic arcade, and left branch **(t)** TP artery. TP artery anastomoses distally with **(m)** PM artery. DP, dorsal pancreatic; TP, transverse pancreatic; PM, pancreatica magna. (Courtesy Dr. Eugenio Bertelli.)

pancreatic artery."[144] Its incidence ranges between 64 and 98%.[126,140,141,142] Its calibre averages 2 mm.[140]

The PM artery is a branch of the splenic artery. Typically the PM artery arises from the middle third of the splenic artery, or at the junction between the middle and distal thirds.[116,126] Less frequently, the PM artery has been reported as originating from the proximal[142] or distal[142] third of the splenic artery, or from the left gastroepiploic artery.[140] Exceptionally, it arises from the superior mesenteric artery[144] or from the hepatic artery.[144]

The PM artery can be double (33-54%)[140,142] or triple (3%).[140]

As soon as it arises, the PM artery enters the substance of the pancreas[126] and passes behind the pancreatic duct.[116] The PM artery anastomoses with the TP artery in 90% of cases, with the DP artery in 20% of cases, and with the CP artery in 20% of cases. Multiple anastomoses are possible.[142]

TRANSVERSE PANCREATIC (TP) ARTERY. The TP artery is also called the "inferior pancreatic artery."[126,127,135] It is an almost constant artery, present in about 90% of cases.[127,141,142] It can be very thin, but in many cases its calibre can be as large as 3 to 4 mm.[98] Usually, the TP artery is detectable angiographically as a single vessel.[97,116] Numerical variations have been reported in a minority of cases.[97,129,134,142]

According to the site of origin, we can distinguish between "long-type" and "short-type" TP arteries. The TP artery is "long-type" in about 30% of cases. The distinction is important because the "short-type" supplies only the body/tail of the pancreas, whereas the "long-type" supplies the head as well.

The "long-type" TP artery may originate from the:
- gastroduodenal artery (2-5%)[98,126,129]
- ASPD artery (10-14%)[126,127]
- right gastroepiploic artery (3-14%)[114,127]
- common hepatic artery[97,144]

The "short-type" TP artery may arise from the:
- DP artery (37-84%)[98,126,127]
- superior mesenteric artery (1-33%)[98,126,127,129]
- IPD artery (6%)[129,134]
- aorta (3%)[134]
- PM artery (1%)[126]

The "short-type" may also arise from a proper hepatic artery coming from the superior mesenteric artery (Fig. 21-42B).

The "short-type" TP artery runs along the inferior edge of the pancreas toward the tail.[115,123,134,138] It is frequently embedded a few millimeters under the surface of its dorsal aspect.[101,118,126,143] In other individuals, the "short-type" TP artery runs superficially for a variable tract before sinking into the substance of the pancreas.[117,127]

The "long-type" TP artery crosses the anterior surface of the pancreatic head, runs superficial to the superior mesenteric vein,[127] and then follows the same course of the "short-type."

The TP artery may join with:
- a branch of the PM artery[115,126,137,138] (70% of cases)[142]
- CP arteries[115,117,126,137,138] (90% of cases)[142]
- left gastroepiploic artery[131]

In some cases the TP artery can bifurcate at the level of the neck of the pancreas; the superior branch can go to the left and upward.[101,148]

The TP artery represents the only connection between two arterial systems that are otherwise independent: the one supplying the head of the pancreas, and the other supplying the body. In other cases, when the TP artery is "short-type," this connection is guaranteed by the prepancreatic arcade.

ARTERIAL DOMINANCE. The DP, PM, and TP arteries, along with other minor branches of the splenic artery, supply the neck, body, and sometimes even the tail of the pancreas. It is important to emphasize that each of these arteries may acquire dominance in supplying its segment of pancreas. In other words, in some cases, just one artery can supply the entire distal part of the pancreas.

The concept of a dominant TP artery (Fig. 21-42) has been previously noted.[98] More recently, a dominant DP artery[149] as well as a dominant PM artery[149] have been demonstrated. However, a single artery supplying the distal segment of the pancreas has often been reported,[150,151] and should not be considered extraordinary.

Tail of the Pancreas (Fig. 21-40)

The tail of the pancreas is supplied by one or more CP arteries and/or by the distal extremities of the arteries of the body.[152] CP arteries have been reported to occur in 66% to 95% of cases,[117,126,134,141,152] but are considered constant by many investigators.[140,142] In many cases (32-36%) the CP artery is single.[140,142] Two CP arteries are detectable in 46% of cases,[140,142] 3 CP arteries in 8-20% of cases,[140,142] and 4 CP arteries in 2% of cases.[142]

The CP arteries arise from:
- a common trunk formed by the left gastroepiploic artery and the inferior splenic branch (50%)[125]
- splenic artery (21%)[125]
- left gastroepiploic artery (20%)[125]
- inferior or superior splenic branches (9%)[125]

The CP arteries run downward or transversely to the right depending on the site of origin. In most cases, they enter the gland from the anterior face of the tail.[117] Anas-

tomosis is usually with the TP artery, less frequently with the PM or DP artery.[142] In 33% of cases, the CP arteries are the sole source of blood for the tail of the pancreas with no apparent anastomosis with the arteries of the pancreatic body.[152]

Some Considerations

If we imagine the pancreas as a stage where the play "Arterial Blood Supply of the Pancreas" is performed, we should consider the arteries as the actors of the play. The plot twist of this play is that the actors play extemporaneously. The spectator (the surgeon) can never be sure about a number of facts: the importance of the role played by each actor (dominance of an artery), the number of actors in the cast (at times all the arteries are present, other times just a few of them supply the pancreas), and the entrances and exits on the set (big variation of the source of each artery). Actors playing roles in other scenarios (i.e. liver, colon) may cross the pancreatic stage as well. There is only one plot device that keeps our play from turning into a tragedy: preoperative angiography.

Venous Drainage (By Bertelli and Colleagues)

The venous drainage of the head of the pancreas is arranged mainly in two venous arcades. The venous arcades follow, on a more superficial plane, the course of the homonymous arterial arcades.[136]

The anterior PD venous arcade is formed by the ASPD and AIPD veins. The ASPD vein empties into the right gastroepiploic vein[118,127,136,153] that, in its turn, drains into the superior mesenteric vein through the gastrocolic trunk.[127,136] The AIPD vein follows the artery behind the uncinate process and the superior mesenteric vessels, and joins the uppermost jejunal vein,[127] usually via a common trunk with the PIPD vein. Less frequently, the AIPD vein drains directly into the superior mesenteric vein.[127,153]

The posterior PD venous arcade is formed by the PSPD and the PIPD veins. The PSPD vein is considered the largest venous trunk of the pancreatic head.[129] The PSPD vein follows the same course as the artery but, in 40% of cases, when it reaches the superior edge of the pancreas,[127,136] it leaves the PSPD artery and crosses behind the choledochus[123,147] before joining the right side of the portal vein.[118,127,153,154] The PIPD vein may join the AIPD vein, or may end directly into the superior mesenteric vein.[154]

In addition to the anterior and posterior PD arcades, two further vessels take part in the venous drainage of the pancreatic head: an inferior venous arcade joining the IPD veins[154] and the anteromedial PD vein.[122]

According to Olsen and Woodburne,[153] the anteromedial PD vein occurs only occasionally. It originates from the confluence of two or more branches coming from the second portion of the duodenum.[147] The anteromedial PD vein crosses the head of the pancreas transversely in an intermediate position.[122,147] It empties into the superior mesenteric vein or, less frequently, into the right gastroepiploic vein.[147]

To summarize: the neck, the body, and the tail of the pancreas are drained by a number of veins that usually follow the same course as the homonymous arteries:

- A system of small superior pancreatic veins (from 3 to 13) empties into the splenic vein.[147,149,153]
- In 34-50% of cases,[149,154] the TP vein originates from the splenic vein,[147] and joins the inferior mesenteric vein,[136,149,153,154] the superior mesenteric vein,[136,153] or the splenic vein itself.[136,149,153] The TP vein, also known as the inferior pancreatic vein,[149,153,154] may be as large as 10 mm.
- A DP vein,[147] a PM vein, and one or more CP veins are usually detectable close to the corresponding arteries.

Lymphatic Drainage

As the position of the pancreas might predict, lymphatic drainage is centrifugal to the surrounding nodes. No standard terminology for those nodes exists, although Evans and Ochsner[155] propose one. None of the efforts to demarcate specific drainage areas of the pancreas have gained wide acceptance. Studies of Cubilla et al.[156] provide the basis for most recent works.

Editorial Comment

Dr. Bertelli appears to be recommending preoperative angiography prior to any pancreatic resection. I don't believe this is standard practice. Imaging techniques will continue to evolve, but currently the techniques for evaluating suspected tumors of the exocrine pancreas are ultrasonography, computed tomographic (CT) scanning, and endoscopic retrograde cholangiopancreatography (ERCP). Variations in arterial anatomy are then recognized and dealt with at the time of any resection. Wider acceptance of helical CT scanning for evaluation of the pancreas would as a byproduct provide the information on the vascular anatomy recommended by Dr. Bertelli. (RSF Jr)

TABLE 21-18. Urologic Complications Related to Pancreas Transplant

Complications	No.	%
Hematuria	35	14.8
Bladder/duodenal segment leak	35	14.8
Reflux pancreatitis	24	10.1
Recurrent urinary tract infection	24	10.1
Urethritis	7	2.9
Urethral stricture/disruption	7	2.9

Source: Chauvin KD, Kittur DS. Pancreas transplantation. In: Cameron JL. Current Surgical Therapy (6th ed). St. Louis: Mosby, 1998, pp. 539-543; with permission.

pressure did not increase after conversion from bladder to enteric drainage.

The increased popularity of pancreas transplants has led to a growing number of potential candidates for retransplants after the initial graft has been lost to technical failure or rejection. Humar and colleagues[349] stated that while retransplants can be performed with a minimal increase in surgical complications, graft survival is slightly inferior and patients require more aggressive monitoring for rejection.

Anatomic Complications of Simultaneous Pancreas-Kidney Transplantation and Pancreas Transplantation

To illuminate urologic and nonurologic surgical complications of transplantation, we present two tables from the work of Chauvin and Kittur[346] (Tables 21-17 & 21-18).

Multiple nephrogenic adenomas of the bladder were reported in a patient three years after a simultaneous kidney-pancreas transplant. Pancreatic drainage was successfully converted from the bladder to the small bowel.[350]

PANCREATIC TRAUMA

Pancreatic injury is an infrequent occurrence. Takashima and colleagues[351] presented a classification of blunt pancreatic duct injuries discovered at pancreatography and their treatment:

- Class 1. Radiographically normal ducts; no surgery required
- Class 2a. Ductal branch damage without leakage; no surgery required
- Class 2b. Ductal branch damage with minimal leakage; drainage laparotomy
- Class 3. Main duct injuries; laparotomy

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