Surgical Anatomy of the Gastroduodenal Artery

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Specific anatomic structures assume importance with breakthroughs in therapy, research and environmental accentuation of disease. The gastroduodenal artery is such.a structure. This vessel due to its location, is a prime target of benign ulceration of the duodenum. Control of hemorrhage from erosion demands a spatial knowledge not obtainable from routine dissections of cadavers. Changes after death alter the anatomic relationships of the gastroduodenal artery. The difference between living and cadaver anatomy is not generally appreciated.

The anatomic relationship of the gastroduodenal artery were studied in 100 necropsies. Representative roentgenograms complemented the dissections. Areas of interest were: (1) separation of the artery from the common bile -duct by the pancreas from the superior border of the pancreas to the hepatopancreatic ampulla, (2) the distance from the pylorus to the gastroduodenal artery and (3) the pattern of distribution of the artery and its branches to the pancreas.

Material and Method

Anatomic Dissection of Necropsy Specimens. —The course of the gastroduodenal artery and its major branches was traced by gross dissection in 25 specimens. The relationship of the artery to the pylorus, pars superior of the duodenum, pancreas and common bile duct was noted.

Injection Studies. — The spatial relationships of the gastroduodenal artery and the common bile duct were studied in 25 specimens presented in transverse section. Jeltrate* in solution was used as the injection medium. In addition, ten corrosion specimens of the arterial supply of the duodenum, pancreas and common bile duct were prepared using Batson's Corrosion Compound as the injection medium.

Review of Roentgenologic Anatomy. — Selected arteriograms demonstrated the thoroughness of this technic for defining normal and variant arterial anatomy of the pancreas, pars superior of the duodenum pnd common duct.

Operative 'T' tube cholangiorams of ten randomly selected patients were projected on a plain film of the abdomen to demonstrate variational anatomy. Lateral views showed the anterior posterior course of the retropancreatic bile duct.

Barium x-ray studies of the upper gastrointestinal tract were made to define positional anatomy of the pylorus and duodenum.

Films were made of patients with pancreatic calculi to outline the variant position of the pancreas.

Results

Anatomic Dissection of Necropsy Specimens. — Course of the Gastroduodenal Artery. — In 22 of 25 dissected specimens, the gastroduodenal artery originated from the common hepatic artery. Two arteries originated from a normal right hepatic and one from a variant right hepatic from the superior mesenteric artery. The length of the suprapancreatic portion varied. When it arose near the point of origin of the common hepatic artery, it was 3-4 cm in length. It coursed along the superior margin of the pancreas and turned caudad at nearly a right angle to descend across the anterior surface of the gland. The usual point of origin at the midpoint of the common hepatic artery gave a suprapancreatic length of 2-3 cm. In a few specimens the suprapancreatic length was as little as 1-1/2 cm. The diameter of the gastroduodenal artery equaled that of the common hepatic artery .

When the gastroduodenal artery reaches the anterior surface of the pancreas, it descends in an almost vertical

axis. It is lodged in a shallow groove in the pancreas and bound firmly by the pancreatic peritoneum. The small supraduodenat artery or arteries branch off immediately after the gastroduodenal artery reaches the pancreas. These supply the retroperitoneal segment of the pars superior of the duodenum. The first major branch is the posterior superior pancreaticoduodenal artery, originating at approximately the superior border of the duodenum. It embraces the common bile duct in its course along the concavity of the duodenum posteriorly and anastomoses with the posterior inferior pancreaticoduodenal artery.

Immediately caudal to the origin of the posterior superior pancreaticoduodenal artery, three to five short branches arise from the gastroduodenal artery. These supply the posterior wall of the duodenum and firmly attach the posterior wall of the duodenum to the anterior surface of the head of the pancreas, This is the beginning area of fixation of the pars superior of the duodenum.

Approximately 1 cm caudal to the inferior border of the pars superior of the duodenum, the major branch of the gastroduodenal artery, the right gastroepiploic. originates. Branches to the pylorus originate from either the gastroduodenal or right gastroepiploic near this juncture. The gastroduodenal continues as two very small arcades. A lateral arcade, the anterior superior pancreaticoduodenal artery, turns abruptly lateral to descend along the anterior concave border of the duodenum and anastomoses with the anterior inferior pancreaticoduodenal artery. The medially directed branch turns toward the midline to anastomose with either the transverse pancreatic or the inferior pancreaticoduodenal artery. All major vessels and arcades are on the respective surfaces of the pancreas.

Distance from the Pylorus to the Retroduodenal Segment of the Gastroduodenal Artery: — In 23 specimens the distance from the pylorus to the retroduodenal segment.of the gastroduodenal artery averaged 2,5 cm ± 0.3 cm variation. In two specimens the entire first portion of the duodenum had a mesentery.

Distance from the Artery to the Common Bile Duct: — At the superior margin of the pancreas. the gastroduodenal artery is separated from the common bile duct by the superior rim of the pancreas which varied from 4 to 12 mm thick, average 8 mm. The separation averaged 10 mm $\pm$ 4 mm at the top of the posterior wall of the duodenum; 18 mm ± 4 mm at the midpoint of the wall and 25-35 mm at the inferior border of the duodenum.

Injection Studies. — Transection Specimens: — The gastroduodenal artery was injected with a red dental impression material and the common bile dud with the same material colored blue or green in 25 specimens. Transverse sections of the pancreas encompassing the duct, pancreas, artery and duodenum were then made. Measurements utilizing this technic are consistent with those obtained by gross dissection. This preparation also gives a clarifying depth of presentation which more clearly shows the complex spatial relations of artery and duct to each other and to the pancreas and duodenum. The gastroduodenal artery, though adherent to the anterior surface of the pancreas, is directly behind the pars superior of the duodenum.

Corrosion Specimens: — Ten corrosion specimens were prepared. The stomach and duodenum were inflated with air prior to injection in order to obtain better depth projections of the foregut arterial supply than would he possible by dissection. The relative size of the various vessels that supply the pancreas as well as anastomoses between the three primary vessels of the celiac artery themselves and between them and the mesenteric arteries were visualized.

Anastomotic Competency — All specimens were easily injected with fluid from the hepatic artery to the superior mesenteric and in the reverse direction.

Review of Roentgenologic Anatomy. — Cholangjograms: Operative cholangiograms of ten patients showed that the course of the common hepatic bile dud and its continuation, the common bile duct, was caudal, slightly medial and slightly dorsal until it engaged the head of the pancreas. Here, the duct turned lateralward at about 90 degrees and dorsalward at 45 degrees to course in a groove in the dorsal surface of the pancreas, somewhat transpancreatically. It terminated in the duodenum through the posteromedial wall at about the midpoint of the descending part.

Selective Celiac and Superior Mesenteric Arteriography: Selective celiac and superior mesentaric arteriograms of 20 patients showed the axis of the gastroduodenal artery was parallel to the vertebral column. The course of the artery varied from the caudal border of T-12 to the midpoint of L-2. The caliber of the gastroduodenal artery and the common hepatic artery were comparable.

Upper Gastrointestinal Series: — Barium x-ray studies revealed marked variation in the anatomy of the stomach. Position depends on such factors as body build, fullness of the stomach, emotional status and the position of the subject. From the pylorus the pars superior of the duodenum ascends with slight dorsal deviation to a position near the neck of the gallbladder. Here, the duodenum turns sharply dorsalward and then caudalward in the right goiter

embracing the head of the pancreas. Oblique roentgenograms are necessary to outline the ascending and descending parts of the duodenum.

Roentgenograms of Pancreatic Calculi: — Four plain abdominal films demonstrated enough calculi to outline the entire pancreas. The head of the pancreas was lying on the L-2 to L-3 vertebral bodies in all subjects. One specimen was transverse and three were oblique with the body and tail axis extending toward the left superior quadrant at 45 to 60 degree angles.

Discussion

The relationships of the gastroduodenal artery to the common bile duct and adjacent viscera are of paramount importance to the alimentary tract surgeon, particularly when dealing with duodenal ulcer. Massive hemorrhage is the most dreaded complication of duodenal ulcer, The gastroduodenal artery is nearly always the vessel eroded. It is necessary to know its precise location for effective therapy. Since the gastroduodenal artery in its suprapancreatic portion varies in length and course, locating it at the time of surgery in the presence of disease can be difficult, especially because of its small diameter. On the anterior surface of the pancreas the gastroduodenal artery is definitely located at the initial fixed point of the duodenum. The artery is superficial in position and densely adherent to the pancreas at this spot so it can be used as a landmark for location and control of the artery.

Lahey suggested placing a "T" tube in the duct for orientation to prevent damage to the common bile duct when - ligating the artery.[1] Accurate spatial knowledge of the structures involved in duodenal ulcer may improve the statistics. The common bile duct and the gastroduodenal artery have fixed positions 8 mm apart at the point where they engage the superior border of the pancreas. Below this point the gastroduodenal artery parallels the vertebral border but the common bile duct diverges laterally and dorsally, thus producing a significant separation of the duct and artery within a short distance, An average minimum of 1Cm separates the common bile dud from the gastroduodenal artery in the retroduodenal segment of the course of the artery, which should provide adequate space for ligating an eroded vessel.

The paucity of arterial supply to the pars superior of the duodenum proximal to the gastroduodenal artery was notable in the corrosion specimens. The short posterior branches of the gastroduodenal artery at the initial fixed point of the pars superior of the duodenum contribute to this fixation. These small vessels, three to five in number, are subject to torsion and traction with changes in position and fullness of the stomach. Since these arteries are the first duodenal arterial supply below the pylorus, arterial supply to the duodenal bulb could be diminished by excessive torsion or traction.

Historical Review

Vesalius, in 1534, devoted the third book of De Humani Corporis Fabrica to the vascular system, The plates demonstrate a general knowledge of the celiac axis and its major branches. A branch of the hepatic artery labeled ramus duodenitis is probably the gastroduodenal artery. Anatomic atlases by Columbus, Eustachius, Bartholinus and Spigelius portrayed a Vesalian concept of the celiac artery distribution. Walther wrote the first monograph devoted solely to the foregut arterial supply.

Haller in 1745 first accurately described the gastroduodenal artery and presented a usable nomenclature of the pancreatic arcades. Bichat and Cloquet, Haller's successors, did not mention variational anatomy. Gray and Bardeleben omitted the posterior pancreatic arcade of the gastroduodenal artery.

In 1832, Meckel described the principle variant anatomy of the gastroduodenal artery. Wilkie was a major contributor to our knowledge of this artery and its branches, describing a supraduodenal and retroduodenal branch. Rio Branco stressed variational anatomy in his thesis. Petrén summarized all significant works up to 1929 and added detailed studies of the branches of the gastroduodenal artery. Adachi's atlas portrayed the gastroduodenal artery and its branches in detail, stressing variational anatomy. Michels made an exhaustive study of the celiac artery and its distribution and presented a comprehensive bibliography. Nebesar and Pollard, based on selective arteriography of the celiac and superior mesenteric arteries, presented the gastroduodenal artery and its branches in the living.

Summary

The surgical anatomy of the gastroduodenal artery was demonstrated by gross dissection and injection technics in autopsy material and by roentgenography in the living. A consistancy of location of this artery in its relation to the pancreas and at a point of fixation of the midpoint of the pars superior of the duodenum was found.

Mayo demonstrated an anemic area on the anterior surface of the duodenum, just distal to the pylorus. when tension was applied to the stomach. Wilkie suggested that a critically low blood supply in this area might cause ulceration.

The corrosion specimens showed a similar critical blood supply at the distal lesser curvature of the stomach. This area depends on anastomoses between a usually small right gastric artery and a voluminous left artery.