

Stuti Ahlawat, Rekha Baby, and Salma K. Jabbour

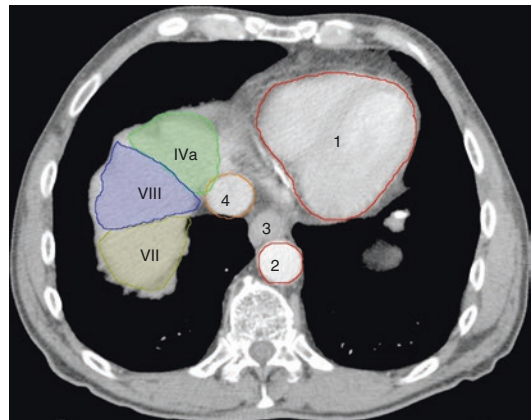
## 2.1 Esophagus

### 2.1.1 Gross Anatomy

- Figures 2.1 and 2.2
- Fibromuscular tube that allows passage of food from the pharynx to the stomach
- About 25 cm long and has a star-shaped lumen with a 2–3 cm diameter
- Begins at the lower border of the C6 [1]
- Cranially enters the thorax at about T1 and occupies the posterior mediastinum [2]
- Caudally enters the abdomen through esophageal hiatus in the diaphragm through the right crus at about T10 [2]
- Has a slight deviation from right to left with three curves: one on the sagittal and two on the frontal plane [1]
- Divided into cervical, thoracic, diaphragmatic, and abdominal [3]
- No serosal covering [4]
- Esophageal wall consists of four layers: mucosa, submucosa, muscularis propria, and adventitia [4]

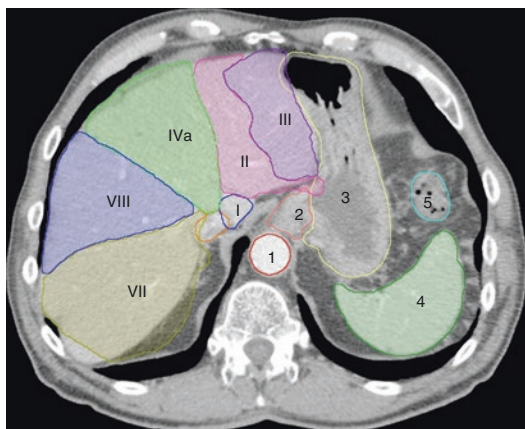
### 2.1.2 Physiologic Points of Constriction/Narrowing [2]

- At the origin of the esophagus at the cricopharyngeus muscle (upper esophageal sphincter)
- By the aortic arch, left anterolateral esophageal surface
- By the left main bronchus
- By the diaphragm at the esophageal hiatus



**Fig. 2.1** 1 heart, 2 aorta, 3 esophagus, 4 inferior vena cava

S. Ahlawat • R. Baby • S.K. Jabbour (✉)  
 Department of Radiation Oncology, Rutgers Cancer  
 Institute of New Jersey, Robert Wood Johnson  
 Medical School, Rutgers University,  
 New Brunswick, NJ, USA  
 e-mail: jabbousk@cinj.rutgers.edu



**Fig. 2.2** 1 aorta, 2 GE junction, 3 stomach, 4 spleen, 5 descending colon

### 2.1.3 Esophageal Portions [3]

- Cervical esophagus starts at about 16 cm from the incisors
- Upper thoracic esophagus begins around 20–21 cm from the incisors
- Mid-thoracic esophagus begins at around 24 cm from the incisors, at the level of the carina
- Lower thoracic esophagus begins around 32 cm from the incisors with the lower esophageal sphincter starting at 37–39 cm from the incisors

### 2.1.4 Cervical Portion [1]

- About 4–5 cm long, begins at the lower border of the C6 and extends to the upper border of T2
- Anteriorly, connected to the trachea by soft connective tissues and tracheoesophageal muscular tissues
- Posteriorly, connected to the deep cervical fascia and spinal column through the retro-esophageal space
- Laterally, connected to the right and left common carotid arteries and recurrent laryngeal nerve on the right

### 2.1.5 Thoracic Portion [1]

- About 16 cm long, extends from T2 to the diaphragm and is located in the posterior mediastinum
- Upper thoracic esophagus, above the level of the mainstem bronchi
  - Anteriorly connected to the trachea and attached to the initial part of the left main bronchus by the bronchoesophageal muscle
  - Connected posteriorly to the vertebral column, up to T4
  - Laterally on right side, attached to mediastinal pleura forming the azygoesophageal recess. On the left side, connected to the mediastinal pleura, the aortic arch, and the initial part of the descending aorta
- Lower thoracic esophagus, below level of bronchi
  - Connected anteriorly to the posterior part of the pericardium covering the left atrium and the lymph nodes at the tracheobronchial bifurcation
  - Laterally connected to the vagus nerve

### 2.1.6 Diaphragmatic Portion [1]

- About 1–2 cm long, connected to the esophageal hiatus
- Anterior to the aortic orifice, attached by the phrenicoesophageal muscle
- The phrenicoesophageal ligament attaches the esophagus to the diaphragm

### 2.1.7 Abdominal Portion [1]

- About 3 cm in length, begins as it transits the diaphragmatic hiatus and ends into the cardia of the stomach along the lesser curvature forming an acute angle with the gastric wall (the angle of His)
- Anteriorly, related to the posterior surface of the left hepatic lobe

- Posteriorly, the abdominal aorta and the medial diaphragmatic pillars
- Right, hepatic caudate lobe
- Left, bottom of the stomach

### 2.1.8 Lymphatic Drainage [4, 5]

- Cervical and thoracic esophagus – extensive submucosal lymphatic system, continuous longitudinally
- Cervical – efferent vessels drain directly or through the paratracheal nodes into the deep cervical nodes
- Thoracic-posterior mediastinal nodes
- Abdominal – left gastric nodes, celiac nodes, and left and right paracardial nodes. Posterior surface – uppermost aortic nodes
- Direct drainage into the thoracic duct

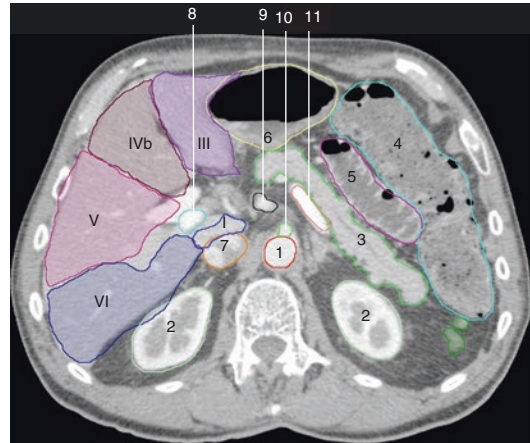
### 2.1.9 Blood Supply [2, 5]

#### 2.1.9.1 Arterial Supply

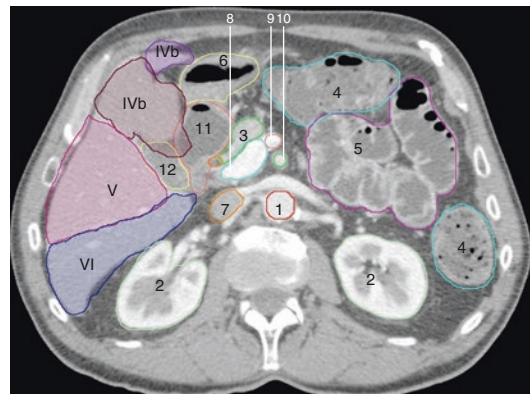
- Cervical: inferior thyroid arteries
- Thoracic: bronchial and esophageal branches of the aorta
- Diaphragmatic and abdominal: esophageal branches of the aorta, left gastric, and phrenic arteries

#### 2.1.9.2 Venous Drainage

- Drains into the submucosa and then into the tributary of the paraesophageal plexus
- Thoracic esophagus drains into the azygos vein. Some drainage into hemiazygos and accessory azygos veins into the anterior and posterior intercostal veins
- Cervical: veins merge into the inferior thyroid vein
- Abdominal: veins drain into the left gastric vein and to the portal vein



**Fig. 2.3** 1 aorta, 2 kidney, 3 pancreas, 4 colon, 5 small bowel, 6 stomach, 7 inferior vena cava, 8 portal vein, 9 celiac axis, 10 superior mesenteric artery, 11 splenic vein



**Fig. 2.4** 1 aorta, 2 kidney, 3 pancreas, 4 colon, 5 small bowel, (jejunum) 6 stomach, 7 inferior vena cava, 8 portal vein/superior mesenteric vein, 9 superior mesenteric artery, 10 splenic vein, 11 duodenum, 12 gallbladder

## 2.2 Stomach

### 2.2.1 Gross Anatomy [1]

- Figs. 2.2, 2.3, 2.4, and 2.12
- Muscular J-shaped, highly vascular organ, in the left upper quadrant of the abdomen

- Gastric wall is made up of four layers: mucosa, submucosa, muscularis propria, and serosa
- Concave right margin: the lesser curvature and a convex left margin, the greater curvature

### 2.2.1.1 Anterior Surface

- Completely covered with peritoneum and adjacent to the diaphragm
- Related to the left lobe of the liver (segments II, III, and IV) and the distal transverse colon

### 2.2.1.2 Posterior Surface

- Covered with peritoneum except at the part closer to the cardia where it touches the diaphragm
- Related to the left adrenal gland, the body and tail of the pancreas, aorta, splenic and hepatic arteries, and portal vein

### 2.2.1.3 Lesser Curvature

- Posterosuperior margin of the stomach
- Starts at the right of the cardia and continues at the right border of the abdominal esophagus and runs a short distance along the right border of the body of the stomach where it turns upward horizontally and descends again to terminate at the level of the pylorus
- The junction of the vertical and horizontal parts of the lesser curvature is called incisura angularis – point of insertion of the hepatogastric ligament connecting the liver and the stomach
- Lesser omentum suspends the stomach from the abdominal wall

### 2.2.1.4 Greater Curvature

- Starts at the cardiac notch and turns upward to form the dome-shaped margin of the fundus and subsequently goes down and medially up to the intermediate sulcus which separates the antrum and the pyloric canal
- Covered by the peritoneum
- Laterally, the anterior and posterior peritoneal visceral sheets merge to form the gastrosplenic ligament, which connects it to the splenic hilum
- Posteriorly, related to the body and tail of the pancreas and a portion of the left hepatic lobe

- The gastrocolic ligament attaches it to the transverse colon, the right colic flexure, and the duodenum and coincides with the anterior root of the greater omentum
- The greater omentum attaches the stomach to the transverse colon, spleen, and diaphragm
- The omental bursa also known as the lesser sac lies behind the stomach and in front of the pancreas; it communicates with the greater sac (main peritoneal cavity) via the epiploic foramen of Winslow behind the hepatoduodenal ligament (the free edge of the lesser omentum)

## 2.2.2 Portions of the Stomach

- Divided into four parts: the cardia, fundus, body, and pylorus

### 2.2.2.1 Cardia

- Connects the esophagus to the stomach
- It is the region following the Z-line of the gastroesophageal junction at which the epithelium changes from stratified squamous to columnar epithelium
- The lower esophageal sphincter is located near the cardia

### 2.2.2.2 Fundus

- Part of the stomach above an imaginary horizontal line drawn from the cardiac notch
- Radiologically, coincides with the gastric bubble (the air-filled part of the stomach which is radiolucent)
- Touches the left hemidiaphragm

### 2.2.2.3 Body

- The central part of the stomach, main site of acid production

### 2.2.2.4 Pylorus

- Connects the stomach to the duodenum
- Antrum: prepyloric vestibule, opening into the body of the stomach. May be demarcated from the pyloric canal by a slight groove
- Pylorus: opens into the duodenum through the pyloric orifice which is surrounded by the pyloric sphincter

## 2.2.3 Blood Supply [6, 13]

### 2.2.3.1 Arterial Supply

- Highly vascular with a rich anastomotic network
- Celiac trunk arises from the abdominal aorta at the level of L1, about 1 cm in length, and divides into the left gastric artery, the common hepatic artery, and the splenic artery
- Left gastric artery runs along the lesser curvature and divides into ascending and descending branches supplying the abdominal esophagus and the lesser curvature, respectively
- Common hepatic artery runs along the superior border of the pancreas to the right and gives rise to the gastroduodenal artery (runs behind the first part of the duodenum) and then continues as the hepatic artery proper
- The left gastric artery anastomoses with the right gastric artery (branch of the common hepatic or hepatic artery proper) along the lesser curvature forming an arcade which gives rise to multiple small arteries supplying the body of the stomach
- The gastroduodenal artery gives rise to posterior superior pancreaticoduodenal artery and then divides into right gastroepiploic artery (runs from right to left along the greater curvature) and anterior superior pancreaticoduodenal artery
- The splenic artery runs to the left along the superior border of the body and tail of the pancreas and gives rise to left gastroepiploic artery (runs from left to right along the greater curvature) which anastomoses with the right gastroepiploic forming an arcade from which multiple small arteries supply the body of the stomach

### 2.2.3.2 Venous Drainage

- Into the portal vein from the left gastric vein which is formed by the union of superior mesenteric and splenic veins. Also the right gastric and right gastroepiploic drain into the portal vein
- Into splenic vein from the left gastroepiploic and short gastric veins
- The prepyloric vein of Mayo lies on the anterior surface of the pylorus

### 2.2.3.3 Lymphatic Drainage

- Three different systems:
- Celiac nodes: from the superior part of the anterior and posterior surfaces of the fundus, body, the antrum, and pyloric canal
- Subpyloric and gastroepiploic nodes: from the inferior part of the anterior and posterior surfaces of the body, the antrum, and pyloric canal on the right
- Gastroepiploic nodes: from the left inferior part of the body and left side of the fundus
- Lymph from the stomach flows into the cisterna chyli through the celiac nodes

---

## 2.3 Pancreas

### 2.3.1 Gross Anatomy [7–10, 11]

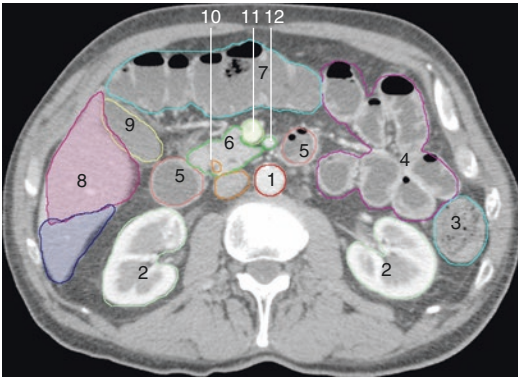
- Figs. 2.3, 2.4, 2.5, 2.11, and 2.12
- Does not have a capsule
- About 12–15 cm long and weighs about 80 g in adults
- Lies transversely at the level of the L1 and L2
- Divided into head (50 % of the parenchymal mass), body, and tail (the remaining 50 %)

#### 2.3.1.1 Head

- Attached to the C-loop of the duodenum, lies to the right of superior mesenteric vein (SMV) and superior mesenteric artery (SMA)
- Uncinate process is the extension of the inferior half of the head to the left, wedged posterior to the superior mesenteric vein
- Terminal part of the common bile duct runs posterior to and, at times, through the upper half of the head to join the main pancreatic duct (of Wirsung) forming the ampulla (of Vater)
- Neck (thinnest part) lies anterior to the junction of the superior mesenteric, splenic, and portal vein

#### 2.3.1.2 Body and Tail

- Body is rectangular and is oriented slightly upward to the left above the aorta and left kidney



**Fig. 2.5** 1 aorta, 2 kidneys, 3 descending colon, 4 small bowel, 5 duodenum, 6 pancreas, 7 transverse colon, 8 liver, 9 gallbladder, 10 bile duct, 11 superior mesenteric vein, 12 superior mesenteric artery

- Tail extends to the splenic hilum in the splenorenal ligament
- The body and tail lie behind the stomach, in the lesser sac
- The transverse mesocolon is attached to the inferior part on the anterior surface of the body and tail

### 2.3.2 Ducts of the Pancreas [12]

Two excretory ducts: the main duct of Wirsung and the accessory duct of Santorini

- The main duct of Wirsung
- Arises from the pancreatic tail traverses horizontally lying between the superior and inferior margins of the gland
- Receives 20–25 secondary ducts entering at right angles to the long axis and turns downward to join the caudal part of the bile duct at the head
- Bile duct and pancreatic duct enter the duodenal wall to terminate on the apex of the major duodenal papilla
- The accessory duct of Santorini
- Connected to the main duct at the junction of the head and the neck
- Lies in the superior part of the head and opens into the duodenum at the apex of the minor papilla

### 2.3.3 Blood Supply [7–10, 11]

#### 2.3.3.1 Arterial Supply

- Highly vascular with supply from the celiac trunk and superior mesenteric artery
- Celiac trunk arises from the anterior abdominal aorta at the level of L1, about 1 cm in length, and divides into the left gastric artery, the common hepatic artery, and the splenic artery
- The superior mesenteric artery arises from the anterior abdominal aorta just below the origin of the celiac trunk at L1 behind the neck
- The common hepatic artery runs along the superior border of the pancreas to the right and gives rise to the gastroduodenal artery (runs behind the first part of the duodenum) and then continues as the hepatic artery proper
- The gastroduodenal artery gives rise to posterior superior pancreaticoduodenal artery and then divides into right gastroepiploic artery and anterior superior pancreaticoduodenal artery
- The inferior pancreaticoduodenal artery arises from the superior mesenteric artery and bifurcates into anterior and posterior branches
- The anterior and posterior branches of the superior and inferior pancreaticoduodenal arteries anastomose to form an arcade – supplies the head, the uncinate process, and the first three parts of the duodenum
- The splenic artery (multiple branches including arteria magna pancreatic) and inferior pancreatic artery (branch of SMA) supply the body and tail

#### 2.3.3.2 Venous Drainage

- Accompany the superior and inferior pancreaticoduodenal arteries
- Superior pancreaticoduodenal vein – drains into the portal vein
- Inferior pancreaticoduodenal vein – drains into the superior mesenteric vein (SMV)
- Uncinate veins – directly into the superior mesenteric vein
- Head – into the gastrocolic trunk
- Body and tail – directly into the splenic vein

### 2.3.3.3 Lymphatic Drainage [7–10, 11]

- Majority of lymphatics lie in the interlobular septa of connective tissue and are closely related to the blood vessels
- Head – pancreaticoduodenal lymph nodes, lymph nodes in the hepatoduodenal ligament, and prepyloric and postpyloric lymph nodes
- Body and tail – mesocolic lymph nodes and lymph nodes along the hepatic and splenic arteries
- Ultimately drains into the celiac, superior mesenteric, para-aortic, and aortocaval lymph nodes

### 2.3.3.4 Nerve Supply [7–10, 11]

- Parasympathetic – posterior vagal trunk via celiac branch
- Sympathetic – T6 to T10 via the thoracic splanchnic nerves and the celiac plexus

## 2.4 Liver [13, 14]

- Figs. 2.1, 2.2, 2.3, 2.4, 2.5, 2.10, 2.11, and 2.12
- Largest internal organ and largest gland and processes all nutrients (except fats) absorbed from the GI tract delivered to the liver via the portal vein
- Stores glycogen and secretes bile
- Anterior and superior surfaces are smooth and convex
- Posterior and inferior surfaces are indented by the colon, stomach, right kidney, duodenum, IVC, and gallbladder
- Peritoneal covering except at gallbladder fossa, porta hepatis, and bare area (posterior superior surface where the liver touches the diaphragm)
- Falciform ligament extends from the liver to anterior abdominal wall and marks the plane, which separates the medial and lateral segments of the left hepatic lobe

### 2.4.1 Blood Supply [13]

- Portal vein provides 75–80 % of the blood supply
- Portal vein carries nutrients from the intestines, pancreatic hormones, and oxygen-rich blood to the liver

- Hepatic artery provides 20–25 % of blood to the liver and is usually a branch of the celiac artery (also possible for the hepatic artery to originate from SMA)
- Biliary tree is more dependent on hepatic arterial blood supply than the liver
- Right, middle, and left hepatic veins collect blood from the liver and return it to the IVC at the confluence of the hepatic veins just below the diaphragm and entrance of the IVC into the heart
- Porta hepatic: site of exit of the portal vein, hepatic artery, and bile duct from the liver
- Portal triad: all branches of the portal vein, hepatic artery, and bile duct travel together
- Route of blood/nutrients through the liver: (1) branches of the portal vein and hepatic artery carry blood into the hepatic sinusoids, (2) hepatocytes detoxify blood and product bile, (3) bile collects into ducts, and blood collects in the central veins (4) hepatic veins

### 2.4.2 Segmental Anatomy of Liver [13, 14]

- Figs. 2.1, 2.2, 2.3, and 2.4
- Eight hepatic segments
- Each segment is drained by its own bile duct (intrahepatic) and hepatic vein branch
- Each segment has its own secondary or tertiary branch of the hepatic artery and portal vein
- Segment 1: caudate lobe, which has independent portal triad and hepatic venous drainage to the IVC

### 2.4.3 Left Lobe

- Segment 2: lateral superior
- Segment 3: lateral inferior
- Segment 4A: medial superior
- Segment 4B: medial inferior

### 2.4.4 Right Lobe

- Segment 5: L anterior inferior
- Segment 6: posterior inferior

- Segment 7: posterior superior
- Segment 8: anterior superior
- Right and left lobes are separated by a plane extending vertically through the gallbladder fossa and middle hepatic vein
- Right anterior and posterior segments are divided by a vertical plane through the right hepatic vein
- Left hepatic vein and falciform ligament separate the left lateral and medial segments
- A plane of the main right and left portal vein marks the superior from inferior segments

## 2.5 Biliary Tract [2]

### 2.5.1 Gross Anatomy

- Figs. 2.5 and 2.11
- Biliary tree is divided into intrahepatic and extrahepatic bile ducts [1]
- Bile produced in the liver, concentrated in the gallbladder, and released to duodenum when fat is present in the duodenum
- Hepatocytes produce bile → bile canaliculi → interlobar biliary ducts → collecting bile ducts → right and left hepatic ducts → common hepatic duct joins the cystic duct (draining the gallbladder) → common bile duct (located at hilum of liver)
- The common bile duct courses along the free edge of the lesser omentum initially, then runs along the posterior part of the duodenum and dorsal head of pancreas to join the main pancreatic duct, and forms the ampulla of Vater (controlled by the sphincter of Boyden)
- Ampulla opens into duodenum through major duodenal (hepatopancreatic) papilla (controlled by the sphincter of Oddi)

### 2.5.2 Blood Supply

#### 2.5.2.1 Arterial Supply

- Hepatic arteries supply intrahepatic ducts
- Cystic artery supplies proximal common bile duct (CBD), right hepatic artery supplies mid-

dle CBD, and gastroduodenal and pancreaticoduodenal supply distal CBD

- Cystic artery (from right hepatic artery) supplies gallbladder

#### 2.5.2.2 Venous Drainage

- Intrahepatic ducts drain to hepatic veins
- CBD drains into portal vein
- Gallbladder drains into liver sinusoids and bypass the portal vein

#### 2.5.2.3 Nerve Supply

- Right phrenic nerve provides sensory innervation
- Celiac ganglion and plexus provide parasympathetic and sympathetic stimulation along with cholecystokinin to allow contraction of biliary sphincters
- Preganglionic parasympathetic fibers – branches of the vagus nerve

#### 2.5.2.4 Lymphatic Drainage

- Same course as arterial supply
- Drain to celiac lymph nodes and lymph nodes at omental foramen
- Common drainage to the porta hepatis and pancreatic head from the gallbladder and also between the aorta and the inferior vena cava
- CBD also drains to the left side of the aorta under the left renal vein

#### 2.5.2.5 Gallbladder

- 7–10 cm in length and 3–4 cm in width and has a storage capacity of 30–50 ml
- Saclike organ located in a fossa on the inferior surface of the right lobe of the liver
- Indents the duodenum
- Parts of gallbladder: fundus (tip, projects below liver edge), body (touches the liver, duodenum, transverse colon), neck, and infundibulum (transition between body and neck)
- Cystic duct is 3–4 cm long and mucosa forms spiral folds of Heister to control bile flow
- Innervated by the hepatic branch of the vagus nerve from the anterior vagal trunk and sympathetic nervous system through the celiac plexus

## 2.6 Colon [2]

- The colon is divided into six parts and is mainly responsible for water absorption from material that was not absorbed or digested by the small intestine (chyle) that results in semi-solid stool/feces. Fecal matter is also stored until defecation

### 2.6.1 Cecum

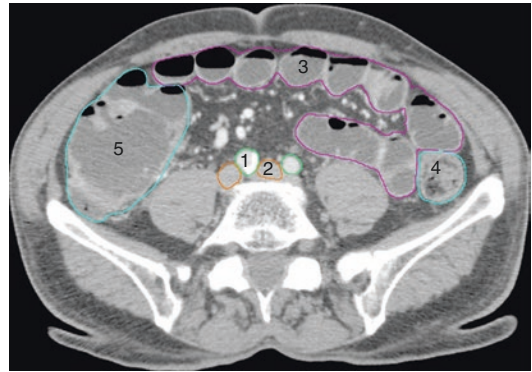
- Encompasses the first portion of the colon, approximately 7 cm in length. Receives contents from the small bowel via the ileocecal valve
- Located in right iliac fossa and attached to the right lateral abdominal wall via cecal folds
- The appendix is a diverticulum arising from the tip of the cecum, varying in length from 6 to 15 cm
- Cecum receives blood supply from ileocolic artery (branch of superior mesenteric artery (SMA)) and vein

### 2.6.2 Ascending Colon

- Figs. 2.5, 2.6, 2.10, 2.11, and 2.12
- Second portion of the colon from the cecum to the transverse colon
- Located in the retroperitoneum, no mesocolon
- 12–15 cm in length
- Vascular supply originates from right colic branch of SMA and superior mesenteric vein (SMV)

### 2.6.3 Transverse Colon

- Fig. 2.5
- Begins at hepatic flexure and extends to splenic flexure
- Completely surrounded by peritoneum
- Vascular supply via middle colic branch of SMA and SMV
- Neurovasculature and lymphatics through transverse mesocolon



**Fig. 2.6** 1 common iliac artery, 2 common iliac vein, 3 small bowel, 4 descending colon, 5 ascending colon

### 2.6.4 Descending Colon

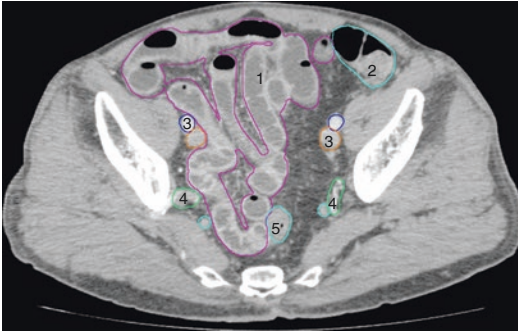
- Figs. 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8, 2.10, 2.11, and 2.12
- Starts at splenic flexure and continues down to left iliac fossa
- Located in retroperitoneum
- Vascular supply via inferior mesenteric artery (IMA) and vein (IMV)

### 2.6.5 Sigmoid Colon

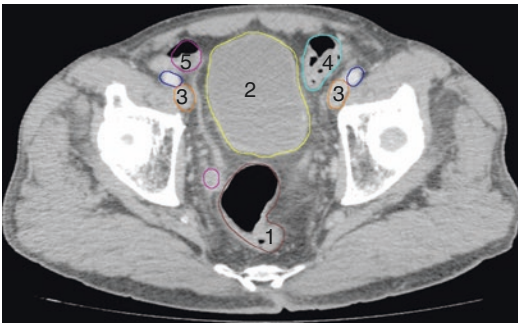
- Fig. 2.7
- Not retroperitoneal, mobile, and covered with peritoneum in the lower part and partially covered in the upper part
- Varies in location and size, but generally located from left iliac fossa to S3 vertebra
- Vascular supply via the IMA and IMV

## 2.7 Rectum [13]

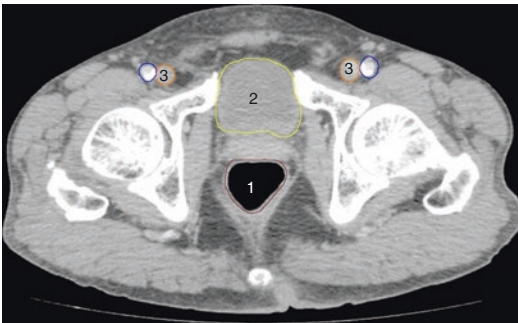
- Figs. 2.8, 2.9, 2.10, and 2.13
- Terminal portion of colon, usually 15–20 cm in length
- Variable location but generally begins around S3 and extends to anal canal
- Superior third of rectum covered with peritoneum on anterior surface and side
- Middle third of rectum covered with peritoneum on anterior surface



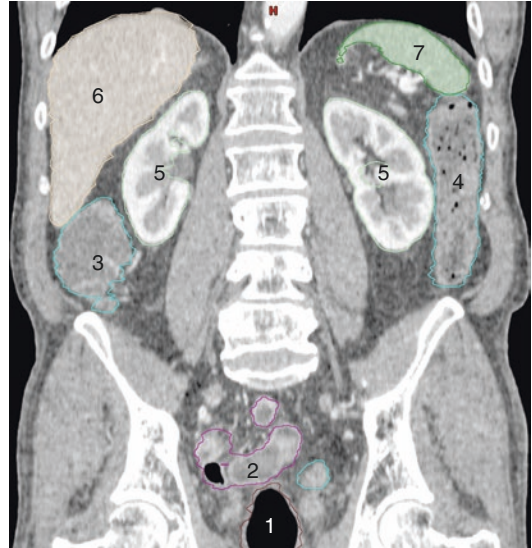
**Fig. 2.7** 1 small bowel, 2 colon, 3 external iliac vessels, 4 internal iliac vessels, 5 sigmoid colon



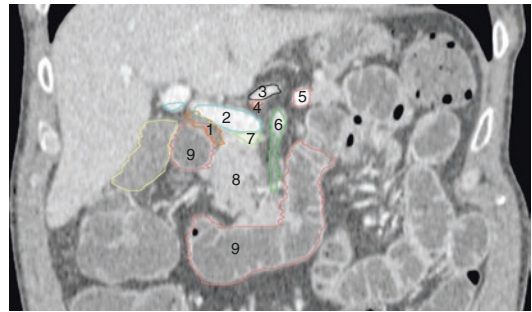
**Fig. 2.8** 1 rectum, 2 bladder, 3 external iliac vessels, 4 colon, 5 small bowel



**Fig. 2.9** 1 rectum, 2 bladder, 3 femoral vessels



**Fig. 2.10** 1 rectum, 2 small bowel, 3 ascending colon, 4 descending colon, 5 kidney, 6 liver, 7 spleen



**Fig. 2.11** 1 common bile duct, 2 portal vein, 3 celiac axis, 4 splenic artery, 5 splenic vein, 6 superior mesenteric artery, 7 superior mesenteric vein, 8 pancreas, 9 duodenum

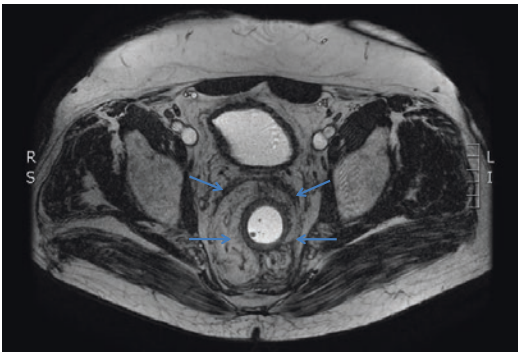
- Presacral fascia covers the rectum posteriorly and is the posterior aspect of the mesorectum

### 2.7.1 Arterial Supply

- Inferior third of rectum below peritoneal reflection
- Mesorectal envelope houses perirectal lymph nodes
- Denonvillier's fascia is the anterior surface of the mesorectum and separates the prostate from the rectum in men or forms the recto-vaginal septum in women
- Mainly supplied via superior rectal artery from IMA
- Middle rectum supplied via middle rectal artery, a branch of internal iliac artery
- Lower rectum (anorectal junction) supplied via inferior rectal artery (branch of internal iliac artery)



**Fig. 2.12** 1 liver, 2 ascending colon, 3 duodenum, 4 pancreas, 5 small bowel, 6 descending colon, 7 stomach, 8 bladder, 9 portal vein



**Fig. 2.13** T2-weighted MRI. Arrows designate mesorectum

- Superior, middle, and inferior rectal arteries all anastomose

### 2.7.2 Venous Drainage

- Main drainage via rectal plexus which drains into superior rectal vein which drains into portal system
- Middle and inferior rectal veins also drain the rectum to internal iliac vein thus into inferior vena cava

- Similar to arterial supply, the venous system anastomoses with each other linking portal and caval system

### 2.7.3 Lymph Node Drainage

- Superior half of the rectum drains to perirectal nodes which drain to inferior mesenteric and lumbar nodes
- Inferior half of the rectum drains middle rectal vessels which drain into internal iliac system. They also anastomose with anal canal lymphatic plexus

## 2.8 Anal Canal [13]

- The anal canal is the end of the gastrointestinal system
- Approximately 3 cm in length
- Starts at the anorectal junction and ends at the anus
- Pectinate or dentate line demarcates the upper two thirds of anal canal from lower third. Vascular supply differentiated based on this line

### 2.8.1 Arterial Supply

- Superior rectal artery above dentate line
- Inferior rectal artery below dentate line

### 2.8.2 Venous Drainage

- Internal plexus drains to superior rectal vein then to portal system above dentate line
- Below dentate line the plexus drains to inferior rectal veins and caval system

### 2.8.3 Lymphatic Drainage

- Above dentate line drain to internal iliac and common iliac nodes
- Below dentate line drain to superior inguinal lymph nodes

### 2.8.4 Pertinent Normal Structures of the Pelvis [13]

- Posterior to the rectum lies the sacrum
- Lateral to the rectum lie the ureters
- Anterior to the rectum:
  - Base of the urinary bladder
  - Males: prostate, seminal vesicles
  - Females: cervix

**Acknowledgment** The authors would like to thank Drs. Tae Kyoung Kim and Dr. Laura Dawson for the CT images that were used for the figures displayed in this chapter.

---

### References

1. Mazza G, Olivetti L. Gastrointestinal tract. Atlas of imaging anatomy. Switzerland: Springer International Publishing; 2015. p. 137–61.
2. Federle MP, Rosado-De-Christenson, Woodward PJ, Abbott GF, Shaaban AM. Imaging anatomy chest abdomen pelvis: Canada: Amirsys Publishing, Inc. 2007.
3. Ugalde PA, Pereira ST, Araujo C. Correlative anatomy for the esophagus. Thorac Surg Clin. 2011;21(2):307–17.
4. Oezcelik A, DeMeester SR. General anatomy of the esophagus. Thorac Surg Clin. 2011;21(2):289–97. x
5. Moore KL, Dalley AF, Agur AM. Clinically oriented anatomy. Philadelphia: Lippincott Williams & Wilkins; 2013.
6. Kapoor VK. Stomach anatomy medscape. 2015;17. <http://emedicine.medscape.com/article/1899301-overview>.
7. Agur AM, Lee MJ. Grant's atlas of anatomy. 10th ed. Philadelphia: Lippincott William and Wilkins; 1999.
8. Romanes G. Cunningham's manual of practical anatomy. Vol. 1. Upper and lower limbs. Oxford: Oxford University Press. p; 1986.
9. Basmajian JV, Slonecker CE, Grant JCB. Grant's method of anatomy: a clinical problem-solving approach. Baltimore: Williams & Wilkins; 1989.
10. Lewis G. Gray's anatomy of the human body. Acad Med. 2000;20. <http://emedicine.medscape.com/article/1899301-overview>.
11. Sinnatamby CS. Last's anatomy: regional and applied. London: Elsevier Health Sciences; 2011.
12. Olivetti L. Atlas of imaging anatomy. Cham: Springer; 2014.
13. Netter FH. Atlas of human anatomy. 6th ed. Philadelphia: Saunders; 2014.
14. Jabbour SK, Hashem SA, Bosch W, et al. Upper abdominal normal organ contouring atlas: a Radiation Therapy Oncology Group consensus. Pract Radiat Oncol. 2014;4:82–9.

<http://www.springer.com/978-3-319-43113-0>

Radiation Therapy for Gastrointestinal Cancers

Hong, T.; Das, P. (Eds.)

2017, VI, 245 p. 51 illus., 48 illus. in color., Hardcover

ISBN: 978-3-319-43113-0