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Pictorial Essay of Linear Endoscopic Ultrasound Examination of Pancreas Anatomy

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Abstract

Endoscopic ultrasound (EUS) is a widely used imaging modality for both diagnostic and therapeutic purposes. Understanding the anatomy is crucial during a curved linear EUS examination. Compared with other advanced endoscopic techniques, the learning curve for EUS is longer, and the training facilities for EUS are also not widely available. The interest and enthusiasm for EUS among endoscopists is limited by the long learning curve and the scarcity of training programs. Imaging of the pancreas is the most common indication of EUS examination, and many endoscopist often face difficulty in understanding the anatomy and orientation of the pancreas on linear EUS examination. In this article, we will discuss the problems encountered during linear EUS examination and how to overcome each problem with a station-wise pancreas examination.

Keywords
- endosonography
- pancreas
- anatomy
- education
- diagnostic imaging

Introduction

Endoscopic ultrasound (EUS) can be performed by a radial or linear echoendoscope. The radial echoendoscope provides a 360-degree view, while the scanning range of a curved linear array echoendoscope varies from 120 to 180 degrees.[1] Therefore, a curved linear array echoendoscope should be rotated either in a clockwise or an anticlockwise direction to obtain a complete view of the structure.

A thorough understanding of the anatomy is vital when performing an EUS. Initially, it can be quite challenging to understand the anatomy; however, some basic steps should be followed before and during EUS training to master the techniques of EUS (►**Table 1**).[2,3]

Basic Principles of EUS Examination

It is imperative to understand the orientation during a linear EUS examination, and for that it is essential to follow the station-wise approach. It is pivotal to carefully observe and interpret the EUS image. The position and direction of the transducer can be determined by the EUS image. For instance, when the descending aorta or pancreas is visible on the screen, it means the transducer is facing posteriorly. Conversely, when the left lobe of the liver or the heart is seen on the screen, it means the transducer is facing anteriorly.[4] Once the orientation and position of the transducer are comprehended, the specific maneuvers required to locate the organ of interest can be determined automatically.

Different terminologies are used during EUS maneuvering (►**Fig. 1**) and it is essential for the endoscopist to know these terminologies while performing an EUS. In conjunction with clockwise and anticlockwise torquing of the scope, minimal push and pull movements of the scope are required to precisely locate a specific organ. For instance, at the gastroesophageal (GE) junction when aorta and celiac artery (CA) are visible, the echoendoscope should be pushed down minimally to locate the pancreas. But why is it necessary to push down the scope? As the pancreas is located below the origin of the CA, the scope must be pushed down to view the pancreas. Another way to learn is by conducting "trial and error" exercises, such as which structures can be viewed and why, based on specific movements at particular stations. This

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Table 1 Beginner's guide for starting endoscopic ultrasound (EUS)

1	Be well acquainted with cross-sectional imaging
2	Read and watch educational materials on the basics of EUS
3	Participate in EUS hands-on training program on animal or simulator models
4	Learn how to handle the scope and understand the knob movements
5	Understand the terminology used in EUS; clockwise and anticlockwise movements, and big knob movements (terminologies used here are downward big knob movements—toward you; upward—away from you)
6	Understand the orientation during EUS examination
7	The first step is identification of structures
8	Focus on easily accessible structures, such as the aorta and the left lobe of the liver
9	Find a homebase at a particular station
10	Learn about one structure and one station at a time
11	Record your own videos and label the structures within them, and later confirm the labeling with mentors or collogues
12	Identify what is normal first, and then know and focus on abnormal pathology
13	Discuss difficulties with peer group and mentor, and try to resolve them
14	Practice daily and repeat all the above-mentioned steps. This is the key to mastering EUS

way, you can learn the specific movements required to obtain the desired images.

In the beginning, an endoscopist may have difficulty in handling the scope, removing the artifacts, and obtaining good images at a particular station. Here are a few steps to overcome these difficulties:

- *Familiarize yourself with the scope:* Learn the proper grip and movements to obtain optimal imaging. Hold the scope straight and avoid excessive twisting of the scope and pushing against resistance while maneuvering.
- Do not rely on the measurement numbers on the scope to determine the position of the scope; use the EUS image instead. From the beginning, make a practice of predicting the location by observing the EUS image. For example, if you see the left atria and the right pulmonary artery (subcarinal space) on the EUS image, it means the echoendoscope is in the mid-esophagus.
- The endoscopic view and EUS image do not corelate. The EUS transducer is placed distal to the camera (~1–1.5 cm). If you see the pyloric ring on the endoscopic view, it means the transducer has already crossed the pylorus and it is in the duodenal bulb. Endoscopic vision should be used to navigate the scope from one place to another to avoid untoward complications.
- *Artifacts recognition and reduction:* Air is the enemy of ultrasound and can interfere in imaging. Air artifacts can be removed by suctioning the air, keeping mucosal tissue

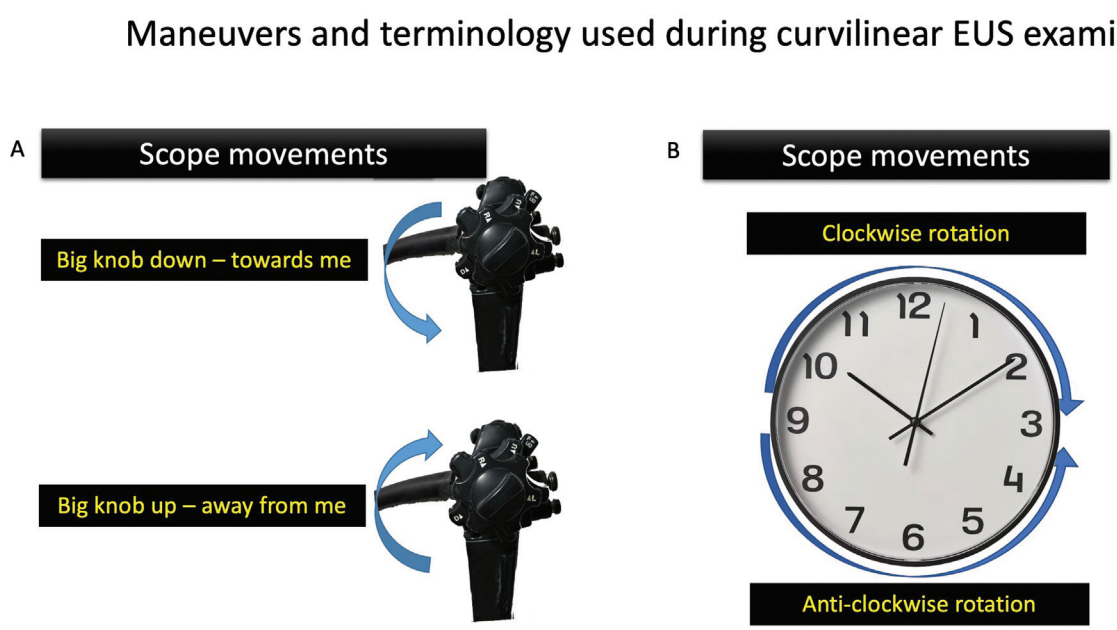

Fig. 1 Terminology used while performing endoscopic ultrasound (EUS). (**A**) Big knob down (toward you) and big knob up (away from you). (**B**) Clockwise rotation (along the clock direction) and anticlockwise rotation (against the clock direction).

and transducer approximation by using the big knob, and water immersion. Avoid unnecessary air insufflation of the lumen while scanning.

- *Rule of 360 degrees:* Linear EUS scanning range varies from 120 to 180 degrees. To get the complete image, an extra 180-degree rotation is required and this can be achieved by a clockwise and an anticlockwise rotation. To see the structure from one particular point, do either a 270-degree clockwise rotation or a 90-degree anticlockwise rotation (►**Fig. 2**). For example, from the GE junction, the spleen can be visualized on clockwise rotation while tracing the pancreas (270 degrees); however, it can also be seen from the left lobe of the liver on anticlockwise rotation (90 degrees).
- *Tracing of structure:* To trace a structure, first bring it to the center of the screen (around the 6 o'clock position) and then perform a clockwise or anticlockwise rotation to trace it (►**Fig. 3**). If the structure is located at the extreme right or left of the screen, tracing it can be challenging. In such instances, utilize a combination of movements along with minimal pull/push movements to bring the structure into the center of the screen.
- *Vessels:* Identifying vessels (with name) has diagnostic and therapeutic importance. Vessels must be traced from the origin until the end or it branches. Veins (oval shaped) change their shape during the course and on compression, while arteries (usually round/tubular) maintain their shape.
- *Imaging from stomach:* Suck all the air out of the stomach until its wall gets collapsed onto the transducer, and follow a station-wise approach. In the stomach, on clockwise rotation the left-sided structures are visible, and on

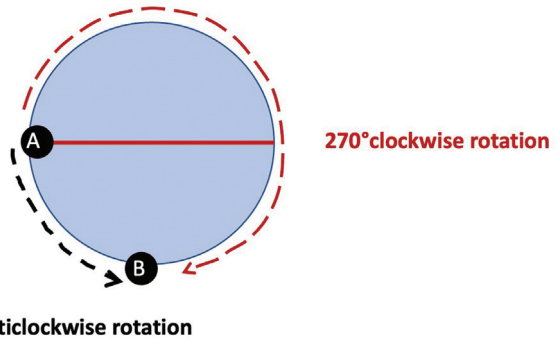

Fig. 2 Schematic diagram explaining the rotation required during linear endoscopic ultrasound (EUS) examination: point B can be traced from point A by a 270-degree clockwise rotation or a 90-degree anticlockwise rotation.

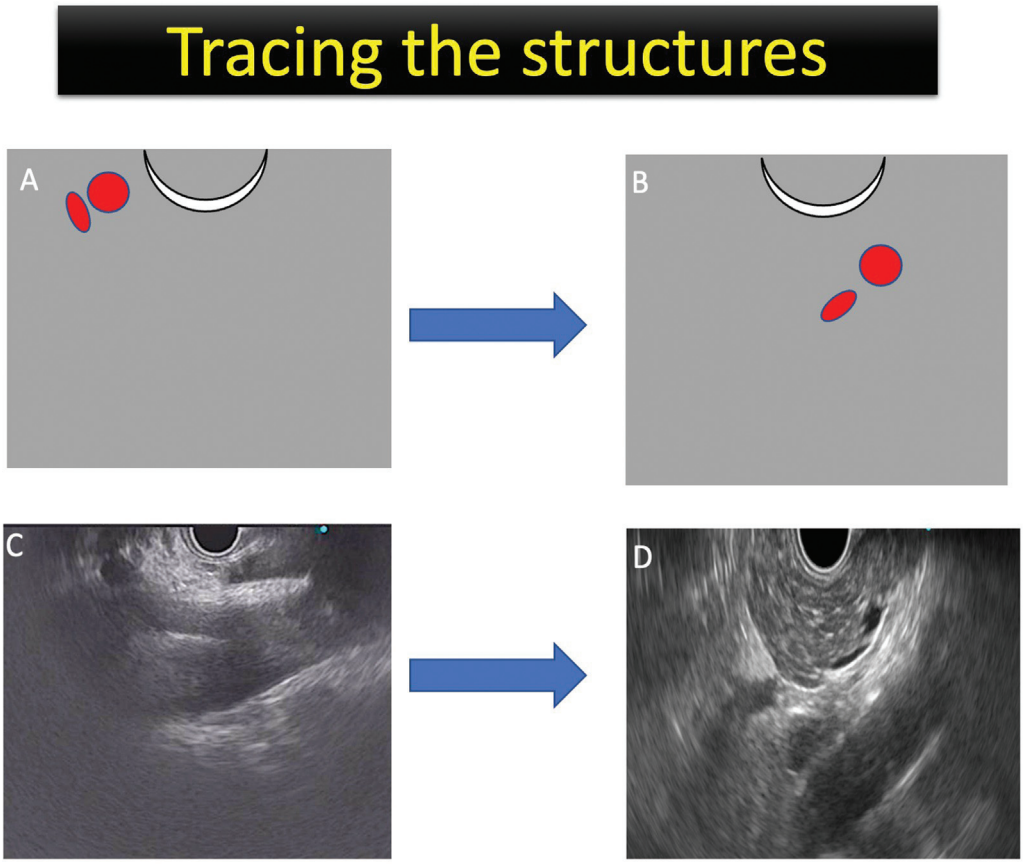

Fig. 3 Tracing structures during endoscopic ultrasound (EUS) examination. (**A**) Schematic diagram showing vessels on the left side of the screen. (**B**) The echoendoscope must be pushed down to bring the vessels into the center of the screen. From here, the vessels can be traced back and forth. (**C**) A representative EUS image showing splenic vessels and pancreas are seen on left of the screen. (**D**) A representative EUS image shows that the pancreas was brought into the center of the image by pushing the echoendoscope down. From this point, tracing the entire pancreas will be easier.

anticlockwise rotation, the right-sided structures are visible. While scanning from the GE junction, sometimes resistance can be felt on clockwise movement. It is typically due to the echoendoscope hitting the lesser curvature. At that point, switch to the endoscopic view, torque the scope in an anticlockwise direction, and push the scope into the proximal body.

- *Imaging from the duodenal bulb:* Duodenal intubation should be done under endoscopic visualization. If crossing the pylorus is difficult, the scope should be pulled/pushed two to three times from the body-antrum. With this maneuver, the stomach remodels and allows smooth entry into the duodenal bulb. The duodenal bulb is a compact space and many structures are visualized. These structures easily get compressed with the transducer. To improve visualization of these structures, it is advisable to instill some water, release the pressure on the big knob, and trace the structure with fine clockwise and anticlockwise movements.
- *Duodenal part 2:* Unlike the shortening of a duodenoscope during endoscopic retrograde cholangiopancreatography, shortening of an echoendoscope should be started from the bulb to facilitate entry of the scope into D2 under endoscopic vision. Never push the scope against the resistance at the D1–D2 junction. To shorten the scope, rotate the small wheel to the right and torque the shaft of the scope in a clockwise direction. In D2, suck out the air and fill it with water as water helps in better acoustic coupling and also helps in stabilization of the scope.
- *Image optimization:* It is an important part of an EUS examination. Understand the different controls and settings on the ultrasound machine to optimize image quality. Adjust parameters such as gain, contrast, depth, frequency, and focus to obtain a clear and detailed image.

Station-Wise Approach for Pancreas Examination

The pancreas can be visualized from the stomach, duodenal bulb, and descending duodenum (►**Fig. 4**; ►**Video 1**).[5–8] Although the entire pancreas can be visualized from the stomach, it is essential to scan from all stations.[9,10] Finding the homebase at a particular station to trace the pancreas is crucial.[11] The normal pancreas echotexture on EUS is described as "salt and pepper" appearance. Embryological variation makes the echotexture of the pancreas different for the ventral pancreas (hypoechoic) and dorsal pancreas (hyperechoic). The ventral pancreas forms the posterior part of the head and uncinate process, while the dorsal pancreas forms the anterior part of the head, genu, body, and tail (►**Fig. 5**).[12] Although slight variation in anatomy and echotexture can occur from person to person, a station-wise approach should be followed for a complete examination.

Video 1

Station-wise examination of the pancreas with curved linear array echoendoscope Online content including video sequences viewable at: https://www.thieme-connect.com/products/ejournals/html/10.1055/s-0043-1770924.

Examination of the Pancreas from the Stomach

The pancreas can be located from the stomach using two methods: (1) from the GE junction by locating the CA or the

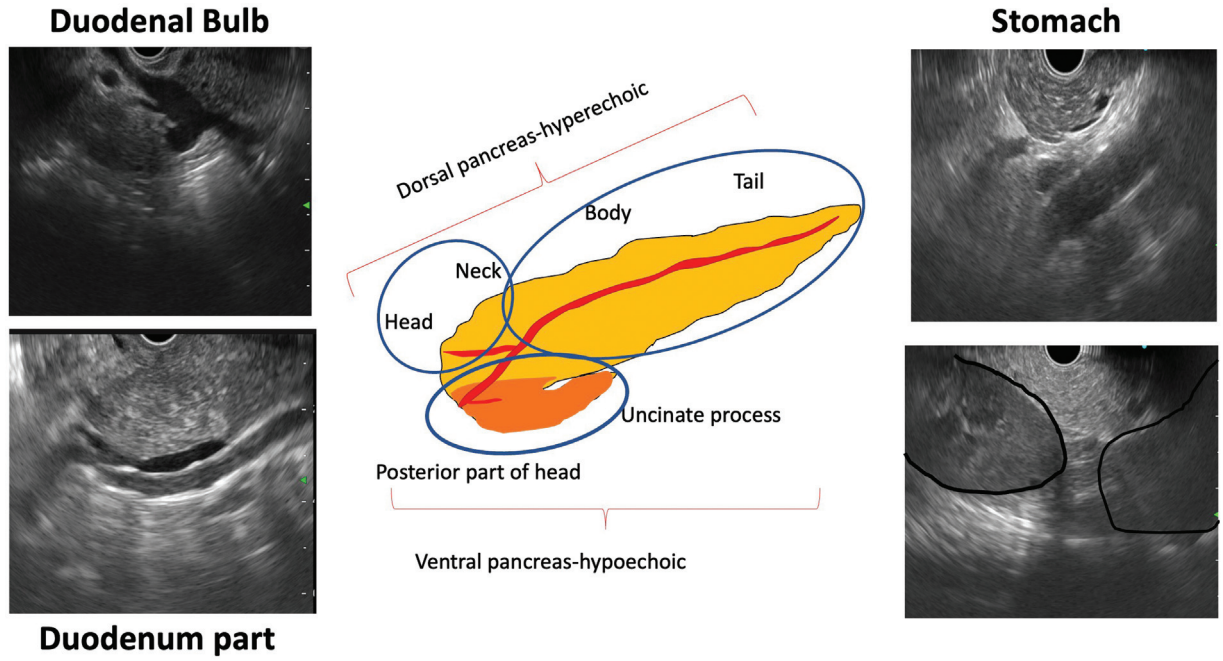

Fig. 4 A station-wise approach for complete pancreas examination and parts of pancreas seen from different stations.

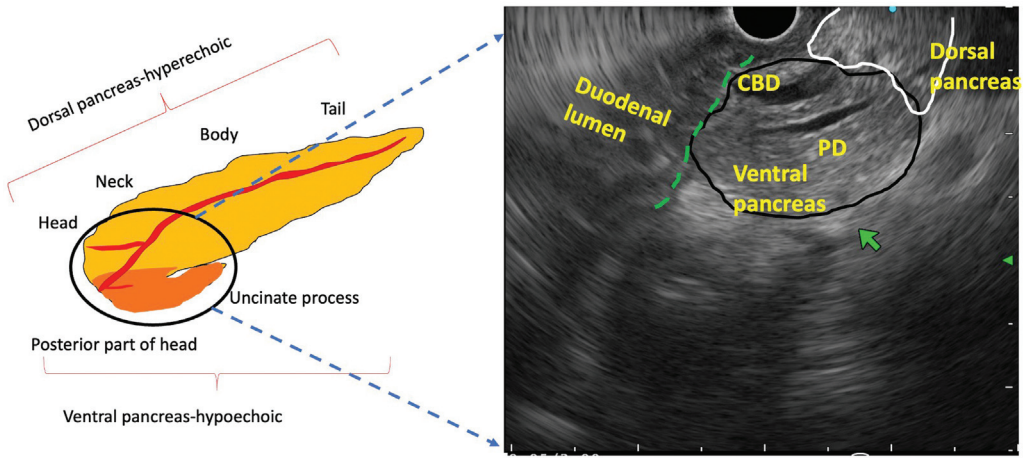

Fig. 5 Parts of the pancreas with embryological variation in echotexture. (**A**) Schematic diagram showing different parts of the pancreas with embryological variation. (**B**) A representative endoscopic ultrasound (EUS) image showing hypoechoic ventral pancreas and hyperechoic dorsal pancreas.

liver hilum using the push method and (2) from the body of the stomach by finding the portal vein confluence (PVC) using the pull method.[7,11]

GE Junction (the Push Method)

By Locating the Celiac Artery

The aorta is the homebase to locate the pancreas from the GE junction. At the GE junction, the left lobe of the liver is visible on the EUS view in the neutral position. Once the left lobe of the liver is visible, rotate the scope in clockwise direction to visualize the umbilical portion of the left portal vein (LPV). On further clockwise rotation (>45 degrees) from the LPV, the intrahepatic inferior vena cava (IVC) will be seen. Once the IVC is seen, rotate the scope again in clockwise direction to see the aorta. At the GE junction, anterior to the aorta, a hypoechoic linear structure can be observed, which corresponds to the crus of the diaphragm. Once the aorta is visible, push the echoendoscope slightly to see the CA (►**Fig. 6**). In the same plane, the splenic artery (SA) and the splenic vein (SV) with some part of the pancreatic parenchyma can be seen on the extreme left upper quadrant of the image. Push the echoendoscope down to bring the pancreas into the center of the screen (►**Fig. 7**). Once the pancreas is in the center of the screen, the position of the transducer is facing posteriorly. From this point, perform a clockwise and anticlockwise rotation to trace the whole pancreas back (toward the tail) and forth (toward genu), respectively.

As the pancreas is placed in a slanting position, clockwise movements and minimal withdrawal are required to visualize the pancreas tail (►**Fig. 8**) and similarly, anticlockwise rotation and pushing of the scope are required to visualize the genu and the head of the pancreas (►**Fig. 9**).[13]

On clockwise rotation when tracing the pancreas body and tail, the splenic vessels, left renal vessels, left kidney, left adrenal gland, and spleen are visualized. The spleen and the left kidney are hallmarks of the pancreas tail. Always trace the pancreas till the splenic hilum to avoid missing of any pancreatic tail pathology (►**Fig. 8F**).

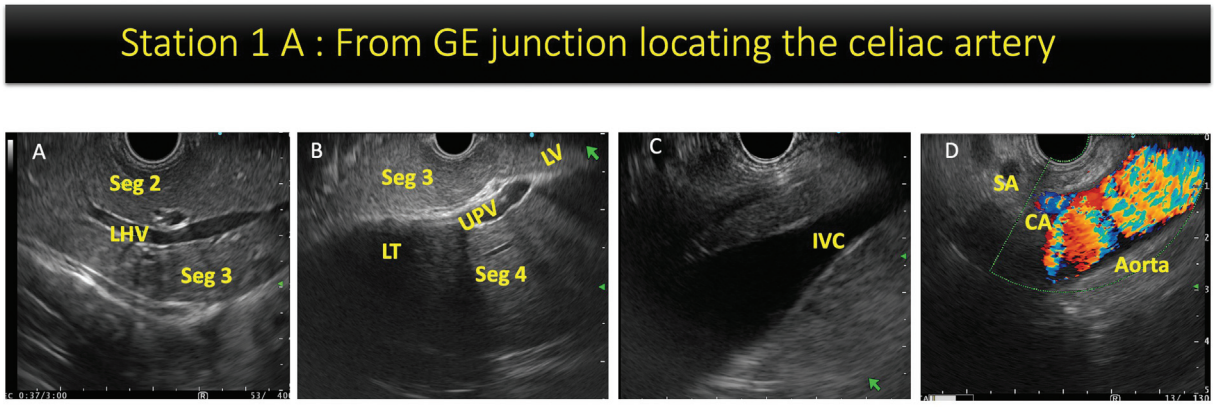

Fig. 6 Locating the celiac artery from the gastroesophageal (GE) junction on endoscopic ultrasound (EUS). (**A**) At the GE junction on EUS, the left lobe of the liver is seen. (**B**) On clockwise rotation from the left lobe, the umbilical portion of the left portal vein (UPV) along with the ligamentum teres (LT) and ligamentum venosum (LV) is seen. (**C**) On further clockwise rotation, the intrahepatic inferior vena cava (IVC) is visualized. (**D**) Further clockwise rotation, the aorta can be visualized along with the celiac artery (CA). If the CA is not seen after visualizing the aorta, push down the echoendoscope slightly. SA, splenic artery.

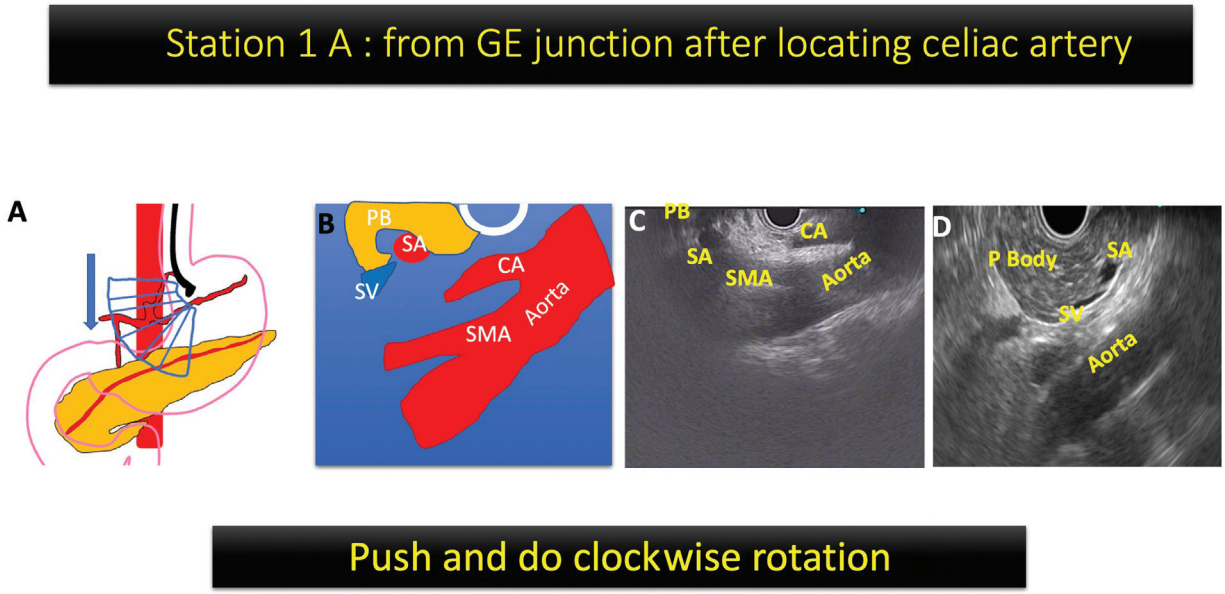

Fig. 7 Locating the pancreas after visualization of the celiac artery (CA). (**A**) Schematic diagram showing the position of the transducer when the CA is seen, with an *arrow* indicating to push down the echoendoscope to see the pancreas. (**B**) Schematic diagram showing structures seen on endoscopic ultrasound (EUS) from the gastroesophageal (GE) junction after locating the CA. (**C**) A representative EUS image showing the aorta, CA, splenic artery (SA), and pancreas body (PB) in the left corner of the screen. (**D**) The pancreas body is visualized after pushing down the echoendoscope after locating the celiac artery. SMA, superior mesenteric artery; SV, splenic vein.

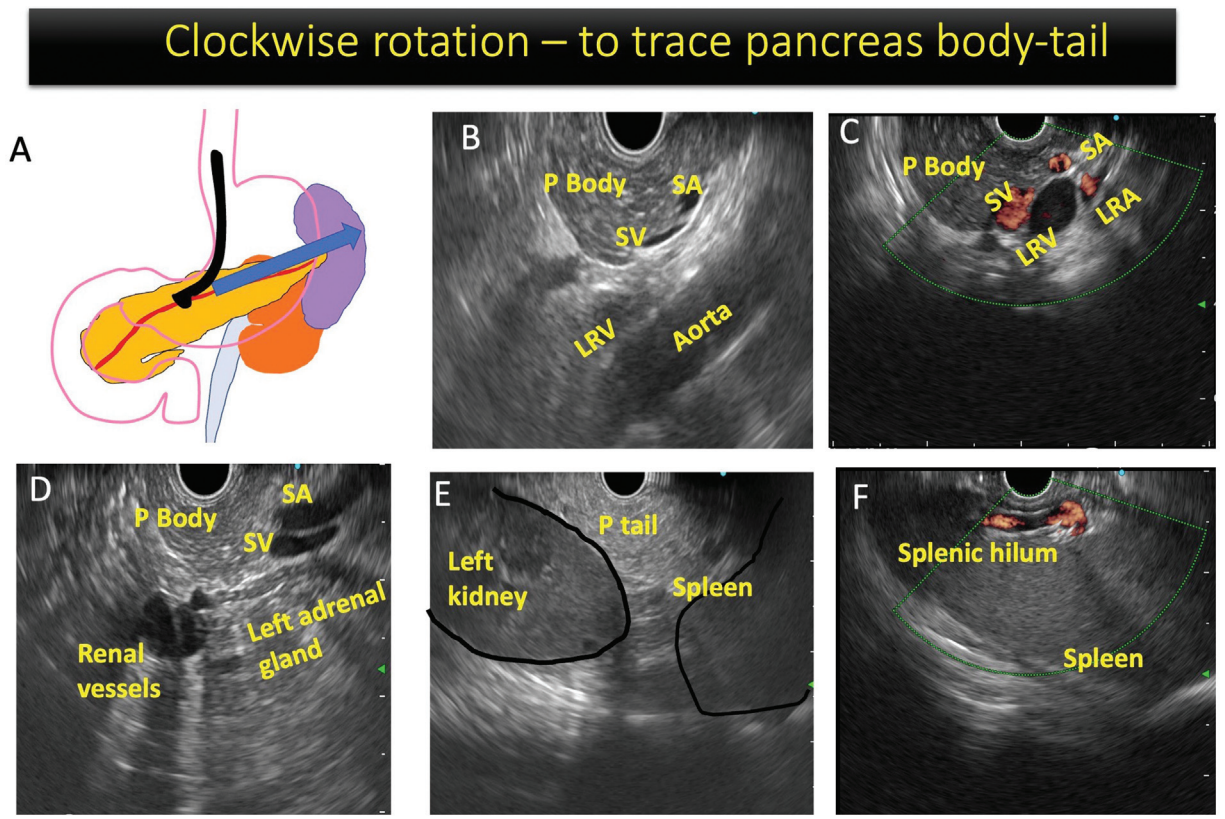

Fig. 8 Tracing the pancreas body and tail from the stomach. (**A**) Schematic diagram showing the pancreas placed in the slanting position. To image the pancreas body and tail, a clockwise rotation and minimal withdrawal of the scope is required as the tail is placed higher up compared with the head-body. (**B**) Endoscopic ultrasound (EUS) image showing the pancreatic body, splenic vessels, left renal vein (LRV), and aorta in the same plane. (**C**) On further clockwise rotation, the pancreas body, splenic artery (SA), splenic vein (SV), LRV, and left renal artery (LRA) are seen. (**D**) On further clockwise rotation, the pancreas body, splenic vessels, left renal vessels are seen entering the left kidney and the left adrenal gland. (**E**) On further clockwise rotation, the pancreatic tail can be seen along with the left kidney and spleen. (**F**) Complete examination of the pancreas by viewing the splenic hilum by clockwise rotation.

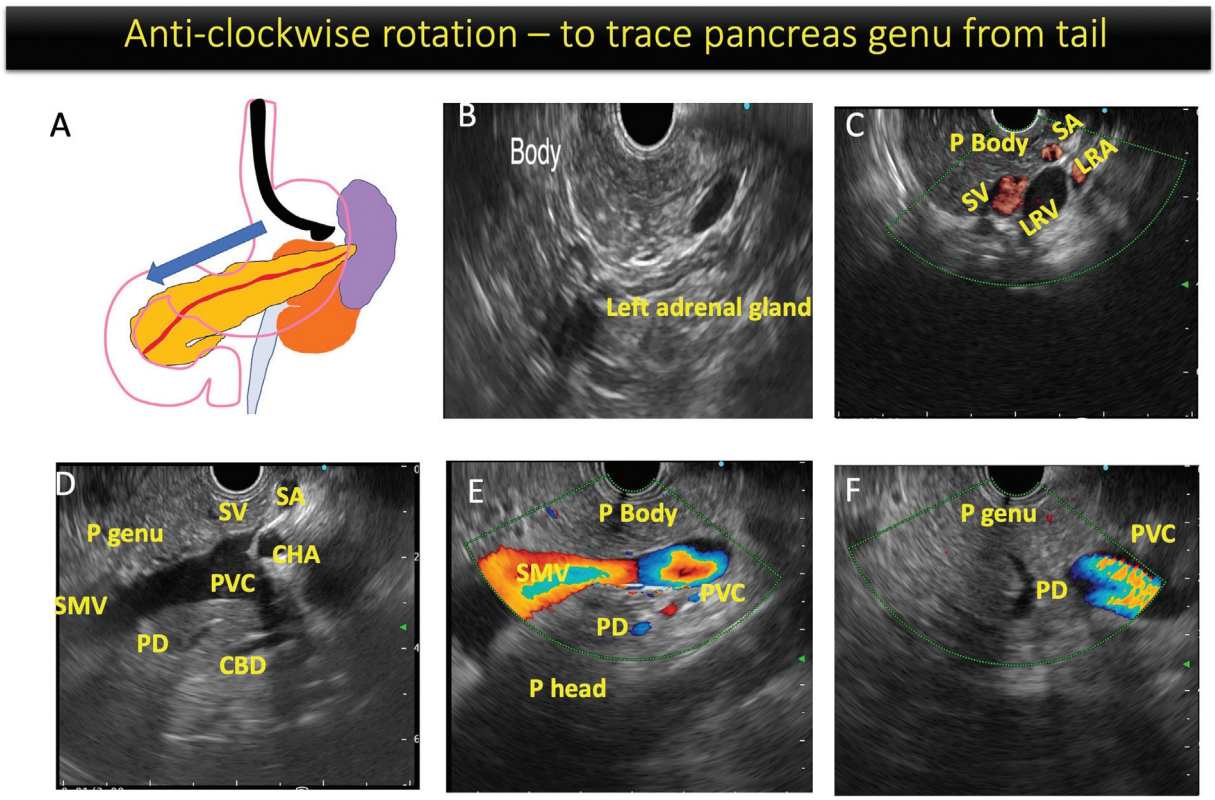

Fig. 9 Tracing the pancreas genu from the pancreatic tail. (**A**) Schematic diagram showing anticlockwise rotation and push movements are required while tracing the pancreas from the tail to the genu. (**B**) On anticlockwise rotation from the tail, the left adrenal gland and the pancreatic body are seen. (**C**) On further anticlockwise rotation, the splenic vessels, left renal vessels, and pancreas body are seen (the image will be similar to a clockwise rotation image). (**D**) On further anticlockwise rotation, the pancreas genu can be seen, and the splenic vein (SV) can also be seen joining the portal vein confluence (PVC) along with the superior mesenteric vein (SMV). In addition, common bile duct (CBD) and common hepatic artery (CHA) can also be seen. (**E**) Pushing down the scope further and keeping an anticlockwise torque, the SMV is seen running horizontally between the pancreas head and body. (**F**) From the SMV on anticlockwise torque, the pancreas genu can be seen clearly with dropping pancreatic duct (PD) in the head region. LRA, left renal artery; LRV, left renal vein; SA, splenic artery.

In case of obese patients, identifying the pancreas can be challenging. Therefore, it is advisable to develop the habit of tracing the splenic vessels, which run parallel to the pancreas (►**Fig. 8B–D**). Tracing splenic vessels serves as a reliable method to locate the pancreas. The left renal vessels are also seen in close proximity to the splenic vessels and should be separately identified.

On anticlockwise rotation, the pancreas can be traced from the tail to the head. While performing anticlockwise rotation, the SV will be seen joining the PVC. On further pushing the scope down from the PVC, the superior mesenteric vein (SMV) will be seen dividing the body and head of the pancreas and on continuing minimal anticlockwise rotation the pancreas genu will be seen (►**Fig. 9**).[11] In the same plane of the PVC, distal intrapancreatic part of the common bile duct (CBD) can also be seen (►**Fig. 9D**). The CBD should be confirmed by color Doppler.[9]

Once the SMV is visible from the stomach, the superior mesenteric artery (SMA) can be visualized by slight clockwise rotation. From this point, the SMA can be traced up to the aorta, and the uncinate process can be examined (►**Fig. 10**).[9] This way the whole pancreas can be scanned from the stomach.[9]

The pancreatic duct (PD) is a small, tubular, anechoic structure running within the center of the pancreas. Therefore, tracing the PD does not require any special maneuvers. During PD examination, it is important to assess for PD dilatation, wall echogenicity, intraductal filling defect (such as calculi), and any anatomical variation. The diameter of normal PD is 4 mm in the head, 3 mm in the body, and 2 mm in the tail. Physiological dilatation of the PD may be seen in elderly people.[12] Pancreas divisum is the most common congenital anomaly of the PD and can be found in 10% of the general population.[14] Diagnosing pancreas divisum is essential, especially in idiopathic recurrent acute pancreatitis. EUS has been reported as a safe and effective modality for diagnosing pancreas divisum with moderate sensitivity (51–95%) and high diagnostic accuracy (97%).[14–16] Pancreas divisum can be precisely diagnosed from the duodenal bulb.

By Locating the Hilum of the Liver

This is another method of locating the pancreas from the GE junction. At the GE junction once the left lobe of the liver is seen, do a clockwise rotation to see the umbilical portion of the LPV. On further slight clockwise rotation (<45 degrees),

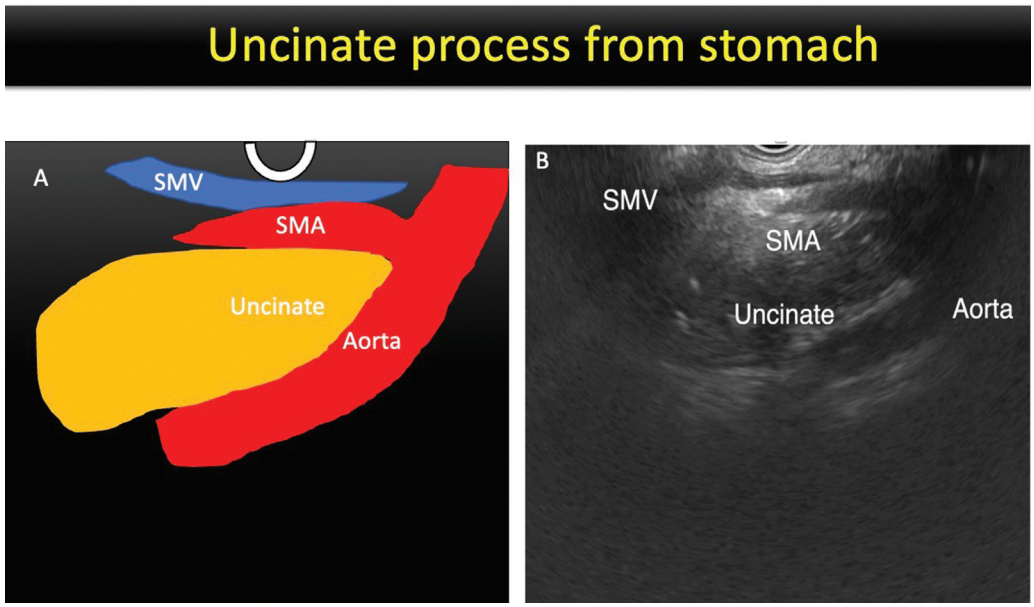

Fig. 10 Visualization of the uncinate process on endoscopic ultrasound (EUS) from the stomach. (**A**) Schematic diagram showing the uncinate process located between the superior mesenteric vessels (SMVs) and the aorta. (**B**) A representative EUS image of the uncinate process from the stomach. SMA, superior mesenteric artery.

the LPV will become round, and the middle hepatic vein (MHV) will also be visible. Once the LPV becomes round, push down the echoendoscope to see the liver hilum. At the liver hilum, the main portal vein (MPV), right hepatic artery (RHA), and common hepatic duct are visible. On pushing the scope further down, the common hepatic artery (CHA), MPV, and CBD can be seen stacked on top of each other. Follow the MPV to the PVC while keeping a clockwise torque. As you proceed in this manner, the pancreas will begin to appear. At the PVC, SV, SMV, and occasionally inferior mesenteric vein (IMV) are visible. The SA is seen running adjacent to the SV. By rotating scope in an anticlockwise direction from the PVC, the pancreas genu will be visualized along with the dropping PD (►**Fig. 11**), and by clockwise rotation the pancreas can be traced to the tail as explained earlier.

From the Distal Body of the Stomach (the Pull Method)

Another way to find the pancreas is to insert the scope into the distal body of the stomach/duodenal bulb and gradually withdrawing it while scanning. This method is not commonly used because it is not as easy to find the pancreas as it is from the GE junction initially. As the majority of the pancreatobiliary pathology lies in the head of the pancreas and can be detected from the duodenal bulb, it may be a good practice to start from the duodenal bulb. After the scanning from bulb, the scope is gradually withdrawn while maintaining a clockwise torque until the PVC/pancreas is identified. The advantage of this method is that resistance will not be encountered like in the push method; however, finding the pancreas can be difficult without a homebase.

Examination of the Pancreas from the Duodenal Bulb

The duodenal bulb is a small and compact place. The echoendoscope will be in a long position with the transducer facing posteriorly and toward the left. From the duodenal bulb, major vessels and organs like the PV, IVC, aorta, CBD, pancreas head and neck, PD, right kidney, and liver (right lobe) can be visualized (►**Fig. 12**).

The homebase in the duodenal bulb is the PV, and it should not be confused with the IVC. The echoendoscope should be wedged in the bulb in a long position. If the scope is not wedged properly and crosses the D1–D2 junction, the right kidney may be visible. In this case, the echoendoscope should be withdrawn slightly to see the PV. Once the PV is visualized, visualizing the CBD and pancreas becomes easier. If the CBD is not visualized, it may be compressed by the transducer. In this case, releasing the big knob and instilling some water may help in visualizing the CBD.

On EUS view from the duodenal bulb, the CBD, MPV, and CHA will be seen placed in sequence, which is the reverse order of the image seen from the stomach (►**Fig. 11E** and ►**Fig. 12A**). The pancreas head is very well seen from the bulb on clockwise rotation and a part of the uncinate process can also be visualized. To visualize the pancreas neck from the bulb, minimal anticlockwise rotation is required from the PVC. The PD is stacked behind the CBD (stack sign), and by clockwise rotation, the CBD, PD, and pancreas head are traced up to the ampulla (►**Fig. 12**).[17] Absence of the "stack sign" and presence of the "crossed duct sign" (PD crossing the CBD) indicates pancreas divisum on EUS.[14] From the ampulla, on anticlockwise rotation, the CBD can be traced till the liver hilum, and the cystic duct and gallbladder can also be visualized while tracing the CBD.

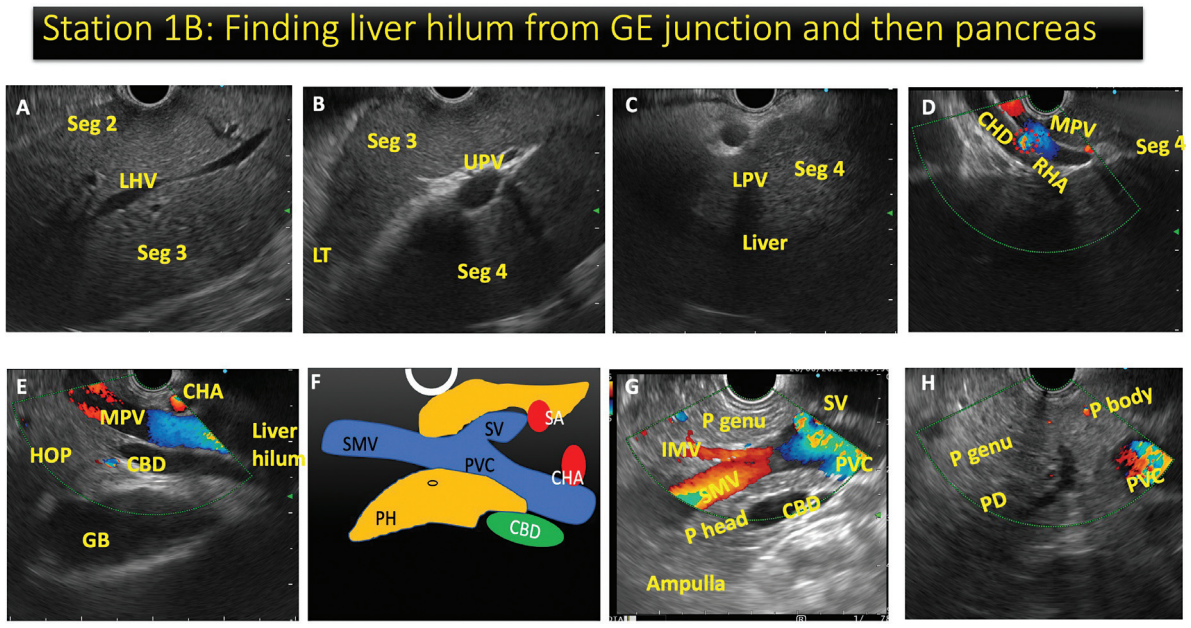

Fig. 11 Locating the pancreas by identifying the liver hilum on endoscopic ultrasound (EUS). (**A**) At the gastroesophageal (GE) junction on EUS, the left lobe of the liver is seen. (**B**) On clockwise rotation, from the left lobe of the liver, the umbilical portion of the left portal vein (LPV) along with the ligamentum teres and ligamentum venosum is seen. (**C**) On slight clockwise rotation, the LPV becomes round shaped. (**D**) When the LPV becomes round, push down the scope to see the liver hilum. At the liver hilum, the common hepatic duct (CHD), main portal vein (MPV), and right hepatic artery (RHA) are seen. (**E**) Trace the MPV by minimally pushing the scope and maintaining a clockwise torque. The common hepatic artery, MPV, and suprapancreatic common bile duct (CBD) are seen. (**F**) Schematic diagram showing the pancreatic head, genu, portal vein confluence (PVC) along with the splenic vein (SV), superior mesenteric vein (SMV), and CBD. (**G**) A representative EUS image showing PVC, SMV, SV, inferior mesenteric vein (IMV), CBD, pancreas head, and genu. After identifying the PVC, the maneuvers are the same to trace the pancreas back and forth by clockwise and anticlockwise rotation, respectively. (**H**) EUS image showing the pancreas genu with dropping pancreatic duct (PD), on anticlockwise rotation from the PVC. Seg 2: segment 2, LHV: Left hepatic vein, seg 3: segment3, LT: Ligamentum teres, UPV: Umbilical portion of left portal vein, LPV: Left portal vein, MPV: main portal vein, Seg 4: segment 4, CHD: Common hepatic duct, RHA: Right hepatic artery, MPV: main portal vein, CHA: common hepatic artery, CBD: Common bile duct, HOP:head of pancreas, GB: Gall bladder, SA:Splenic artery, SV: Splenic vein, PVC: portal vein confluence, SMV: Superior mesenteric vein, PH : pancreatic head, IMV:inferior mesenteric vein, p head: pancreatic head, P genu: Pancreatic genu.

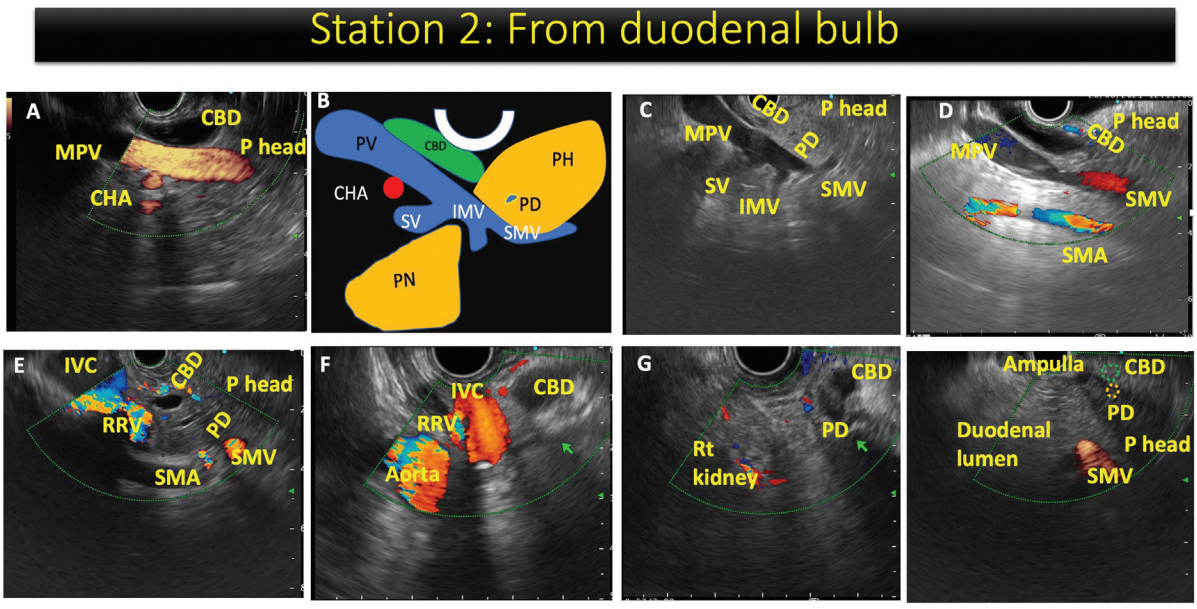

Fig. 12 Pancreas examination from the duodenal bulb. (**A**) The main portal vein (MPV) is the home base in the duodenal bulb. On endoscopic ultrasound (EUS) image, an anechoic common bile duct (CBD) is seen, then main portal vein (MPV) and common hepatic artery (CHA) are visualized in sequence. This is the reverse order of the stomach examination. (**B**) On slight clockwise rotation, the portal vein confluence (PVC), splenic vein (SV), superior mesenteric vein (SMV), inferior mesenteric vein (IMV), CBD, and pancreas head (PH) along with the pancreatic duct (PD) are visualized. (**C**) A representative EUS image depicting the same. (**D**) On slight clockwise rotation, the CBD, PH, SMV, and superior mesenteric artery (SMA) are visualized. (**E**) On further clockwise rotation, the intrapancreatic CBD, pancreas head (PH), PD, and inferior vena cava (IVC) along the right renal vein (RRV) are seen. (**F**) On clockwise rotation, the IVC, RRV, aorta, and distal-most part of the CBD seen. (**G**) On further clockwise rotation, the distal-most part of the CBD and PD along with the right kidney can be seen. (**H**) Further on fine clockwise rotation, the ampulla can be seen from the duodenal bulb along with the terminal part of the CBD and PD.

Duodenum Part 2

The aorta is the homebase in the descending duodenum. The ampulla, pancreatic head, uncinate process, proximal PD, intrapancreatic CBD, and mesenteric vessels can be visualized from D2. In the deep descending duodenum, the transducer faces posteriorly so parts of the IVC and aorta are visible, and on anticlockwise rotation, the right-sided structures (right to the aorta) such as the infrarenal IVC and right kidney are visible, while on clockwise rotation, the aorta and pancreas are visible.

Once the aorta is seen, slowly withdraw the scope while maintaining a clockwise torque until the pancreas head comes into view. Along with the pancreas head, the uncinate process and mesenteric vessels (SMV is closer to the transducer) can also be seen. On further withdrawal and clockwise rotation, the CBD and PD will be seen joining the ampulla. At the ampullary level, release the big knob, and instill some water to push away the ampulla. This is to ensure that small stones or lesions at the ampulla are not missed. At the ampullary level, if either of the ducts is not visualized, slight maneuvering of the scope is required. When CBD is visualized, a slight clockwise rotation is required to see the PD. Conversely, when PD is visualized, minimal anticlockwise rotation should be done to visualize the CBD (►**Fig. 13**).[12,17]

From the ampulla, the PD and CBD can be traced until the pancreas body and liver hilum, respectively. To trace the PD from the ampulla, gently withdraw the scope while maintaining a clockwise torque. During this maneuver, the scope may slip into the stomach and directly lie on the genu/body of the pancreas. This allows tracing of the PD from the ampulla to the body of the pancreas. The inability to trace the PD from the major papilla to the pancreatic body is also suggestive of pancreas divisum.[14] A similar maneuver is performed to trace the CBD from the ampulla to the liver hilum, but with an anticlockwise torque.

Understanding the orientation from the descending duodenum can be difficult, and stabilizing the scope can be quite challenging at first. Therefore, it is advisable to learn this station once you feel confident in other station examinations.

Conclusion

Understanding the anatomy with the linear EUS is crucial in mastering the technique. A station-wise approach can be helpful in comprehending the orientation of the pancreas. For complete examination of the pancreas, a station-wise approach should be followed, and examination of the pancreas should be repeated multiple times until you feel comfortable with your performance. It is good practice to examine the pancreas during every EUS examination. The best way to learn

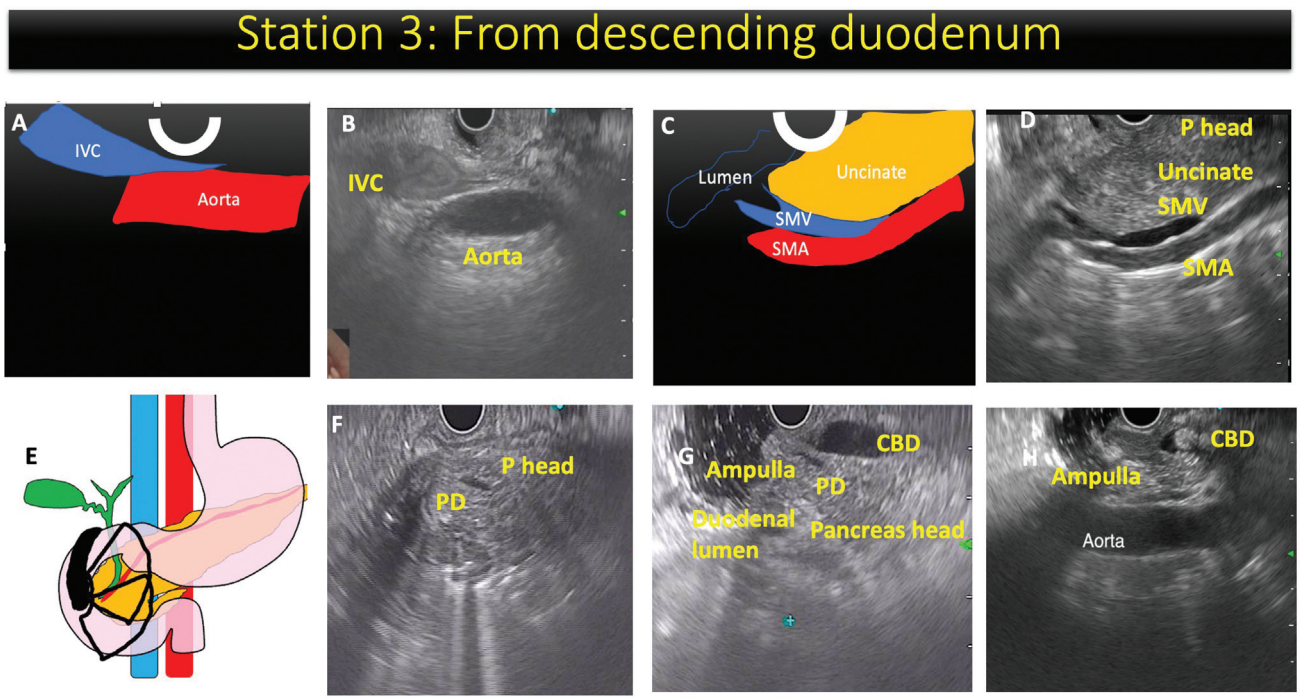

Fig. 13 Pancreas examination from the duodenum part 2. (**A**) The homebase in descending duodenum is the abdominal aorta. Schematic diagram showing inferior vena cava (IVC) and aorta from D2. (**B**) A representative endoscopic ultrasound (EUS) image showing the IVC and aorta from D2. (**C**) Once aorta is seen, withdraw the scope slowly and maintain clockwise torque. The pancreas and mesenteric vessels will start appearing. A schematic diagram showing the pancreas head, uncinate process, and superior mesenteric vessels (SMV; it is closer to the transducer). (**D**) A representative EUS image of the pancreas head, uncinate process, and SMVs. (**E**) Schematic diagram showing the position of the transducer in D2 along with the scanning range. (**F**) On further withdrawal, the ampulla will start appearing along with the pancreatic duct (PD). (**G**) A slight anticlockwise rotation is required to see the common bile duct (CBD) from the PD; similarly a clockwise rotation is required to see the PD when the CBD is visualized at the ampulla. An EUS image showing the ampulla with both the PD and CBD. (**H**) An EUS image showing the CBD with stones and the abdominal aorta. From the ampulla, the CBD can be traced to the liver hilum by slow withdrawal and keeping an anticlockwise torque. For tracing the PD from the major papilla to the body, gradual withdrawal and clockwise torque is required.

EUS is to read about it, watch videos of experts performing the procedure, observe their body movements, record your own videos, label the structure, discuss the difficulties encountered during EUS examination, and repeat these steps over and over again. Mastering basic anatomy will undoubtedly aid in advanced therapeutic EUS and to master EUS, what one can do is practice, practice, and practice.

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Conflict of Interest
None declared.

References

1 Mishra G. Equipment. In: Hawes RH, Fockens P, Varadarajulu S, eds. Endosonography. 4th ed. Philadelphia, PA: Elsevier; 2019: 15–28
2 Wong JYY, Kongkam P, Ho KY. Training in endoscopic ultrasonography: an Asian perspective. Dig Endosc 2017;29(04):512–516
3 Ligresti D, Kuo YT, Baraldo S, et al. EUS anatomy of the pancreatobiliary system in a swine model: the WISE experience. Endosc Ultrasound 2019;8(04):249–254
4 Committee EFS, Yamao K, Irisawa A, et al. Standard imaging techniques of endoscopic ultrasound-guided fine-needle aspiration using a curved linear array echoendoscope. Digest endoscopy 2007;19:S180–S205
5 Hawes Rh, Fockens P, Varadarajulu S. How to perform endoscopic ultrasonography in the pancreas, bile duct, and liver. In: Hawes RH, Fockens P, Varadarajulu S, eds. Endosonography. 4th ed. Philadelphia, PA: Elsevier; 2019:129–139.e2.
6 Irisawa A. Current role of radial and curved-linear arrayed EUS scopes for diagnosis of pancreatic abnormalities in Japan. Dig Endosc 2011;23(Suppl 1):9–11
7 Bapaye A, Aher A. Linear EUS of the pancreas, biliary tract and liver. In: Akahoshi K, Bapaye A, eds. Practical Handbook of Endoscopic Ultrasonography. Tokyo: Springer; 2012:165–205
8 DeWitt JM, Levy MJ, Fockens P. Learning EUS tricks from the masters. Gastrointest Endosc 2011;74(05):1116–1118
9 Dhir V, Adler DG, Pausawasdi N, Maydeo A, Ho KY. Feasibility of a complete pancreatobiliary linear endoscopic ultrasound examination from the stomach. Endoscopy 2018;50(01):22–32
10 Palazzo L. How to perform EUS in the pancreaticobiliary area. Minerva Med 2014;105(05):371–389
11 Irisawa A, Yamao K. Curved linear array EUS technique in the pancreas and biliary tree: focusing on the stations. Gastrointest Endosc 2009;69(02):S84–S89
12 Sharma M, Rai P, Rameshbabu CS, Arya S. Imaging of the pancreatic duct by linear endoscopic ultrasound. Endosc Ultrasound 2015;4(03):198–207
13 Erickson RA, Sing JT Jr. EUS of the Normal Pancreas. Atlas of Endoscopic Ultrasonography. Chichester, UK: Wiley-Blackwell; 2011:24–28
14 Rana SS, Bhasin DK, Sharma V, Rao C, Singh K. Role of endoscopic ultrasound in the diagnosis of pancreas divisum. Endosc Ultrasound 2013;2(01):7–10
15 Lai R, Freeman ML, Cass OW, Mallery S. Accurate diagnosis of pancreas divisum by linear-array endoscopic ultrasonography. Endoscopy 2004;36(08):705–709
16 Sharma M, Pathak A, Rameshbabu CS, Rai P, Kirnake V, Shoukat A. Imaging of pancreas divisum by linear-array endoscopic ultrasonography. Endosc Ultrasound 2016;5(01):21–29
17 Sharma M, Pathak A, Shoukat A, et al. Imaging of common bile duct by linear endoscopic ultrasound. World J Gastrointest Endosc 2015;7(15):1170–1180