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SPECIAL REPORT

STANDARD IMAGING TECHNIQUES OF ENDOSCOPIC ULTRASOUND-GUIDED FINE-NEEDLE ASPIRATION USING A CURVED LINEAR ARRAY ECHOENDOSCOPE

EUS-FNA Standardization Committee
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Standard imaging techniques using a curved linear array echoendocope are summarized to facilitate the attainment of expertise in endoscopic ultrasonography and endoscopic ultrasound-guided fine needle aspiration, and to promote the widespread use of this diagnostic and therapeutic tool.

Typical images of the mediastinal organs, the bilio-pancreatic systems and neighboring organs by scanning from the esophagus, stomach, duodenal bulb, and descending portion of the duodenum, are shown in a sequential manner. The basic techniques of endoscopic ultrasound-guided fine needle aspiration are also presented.

Key words: endoscopic ultrasonography, endoscopic ultrasound-guided fine needle aspiration, standard imaging, scanning method, curved linear array echoendoscopy.

INTRODUCTION

Endoscopic ultrasonography (EUS) is now widely accepted as a powerful tool for the diagnosis of diverse gastrointestinal disorders. Current ultrasonic endoscopes employ two types of scanning methods: radial scanning and convex scanning. Radial-scanning ultrasonic endoscopes are extensively used in Japan for imaging of small mural lesions, and diagnoses and staging of cancer. Endoscopic ultrasound-guided fine-needle aspiration (EUS-FNA), on the other hand, has only recently begun to be used technique for pathological diagnosis. It is however still an under-utilized tool.

One of the factors hindering the wide-spread use of EUS-FNA is the difficulty in understanding ultrasound anatomy with a curved linear array echoendoscopy ultrasonic endoscope. To deal with this problem, we formed a committee whose main objective was to establish standard scanning techniques for EUS examinations with curved linear array echoendoscopes.

This handbook is a convex scanning version, or companion volume to 'Standard Imaging Techniques in the Pancreatobiliary Region Using Radial-Scanning Endoscopic Ultrasonography.' The descriptions in this handbook are roughly divided into standard imaging techniques and endoscopic ultrasound-guided fine-needle aspiration techniques. The section on the standard imaging techniques follows the style of radial-scanning version wherever possible for the ease of reading, but a section on how ultrasound images look has been added to facilitate greater understanding. In addition, a section dedicated to specific tips and tricks for safe, sure performance of EUS-FNA is also included. We hope this handbook will help readers acquire a better understanding of techniques for diagnosis and therapy with curved linear array echoendoscope.

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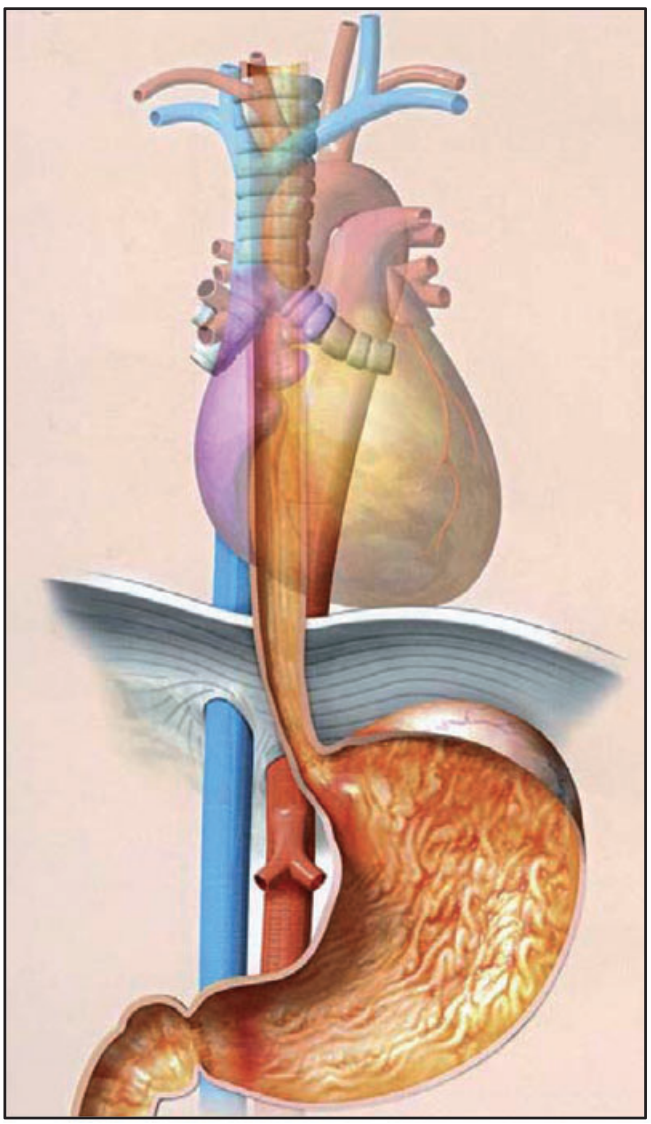
1. Standard Scanning Techniques

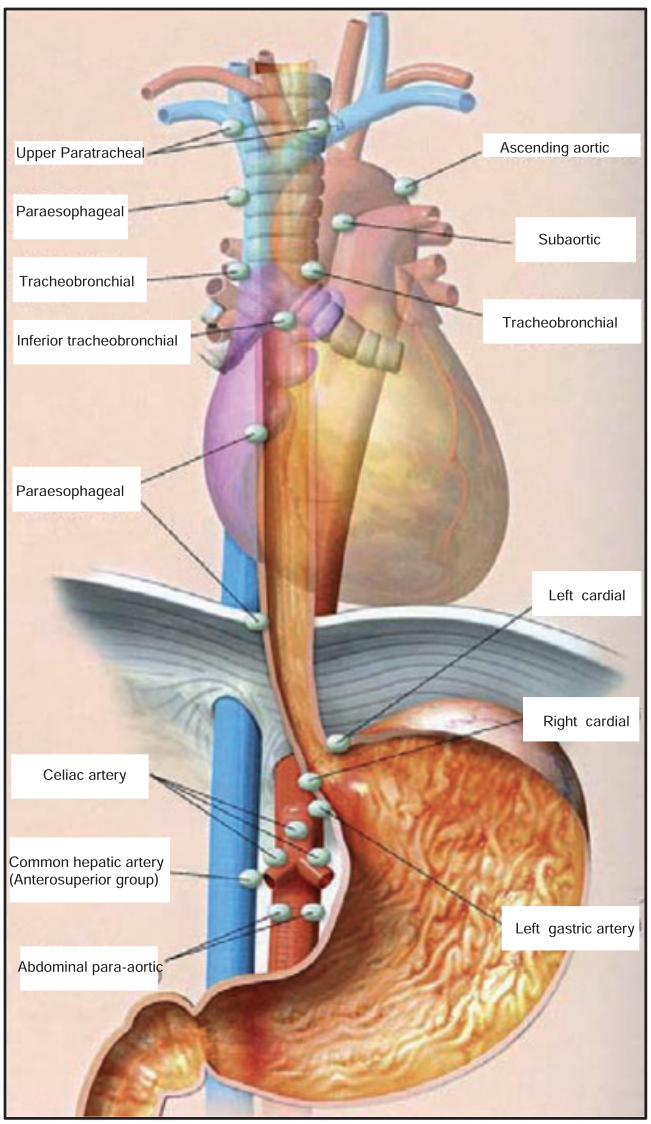
■ Indices for scanning technique

This section describes the standard techniques for imaging with curved linear array echoendoscope by dividing the scanning target positions into four regions. The following tables show the landmark structures observed from each scanning position.

Scanning Position	Landmarks	Tips
Esophagus	Descending aorta Inferior vena cava (IVC) Azygos vein Right atrium, left atrium & left ventricle Ascending aorta Pulmonary artery Tracheal bifurcation Aortic arch	Insert the scope into the stomach past the EG junction ,and visualize the liver, hepatic veins and IVC, and then observe the entire image while visualizing each of the indices.)

■ Esophagus



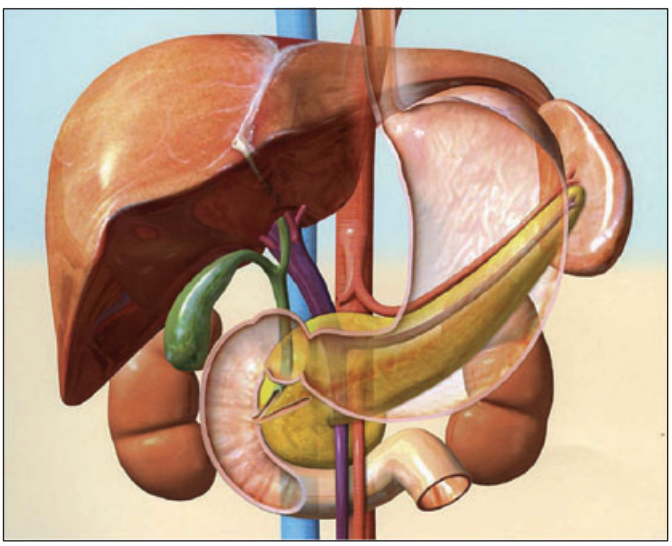


Scanning Position	Landmarks	Tips
Stomach	Hepatic veins Abdominal aorta Celiac artery Splenic artery/vein Superior mesenteric artery/vein Portal vein Liver Pancreas Left kidney Spleen Left adrenal gland Bile duct Gallbladder	Insert the scope till the EG junction. After recognizing the hepatic veins, observe the entire image while imaging each of the indices. Alternately, observe the duodenal region first and then observe other regions while withdrawing the scope toward the oral side.

Scanning Position	Landmarks	Tips
Duodenal bulb	Portal vein Superior mesenteric artery/vein Splenic vein IVC Abdominal aorta Gallbladder Bile duct Pancreatic head Pancreatic body	Insert the scope as far as the duodenal bulb and observe using the push technique.

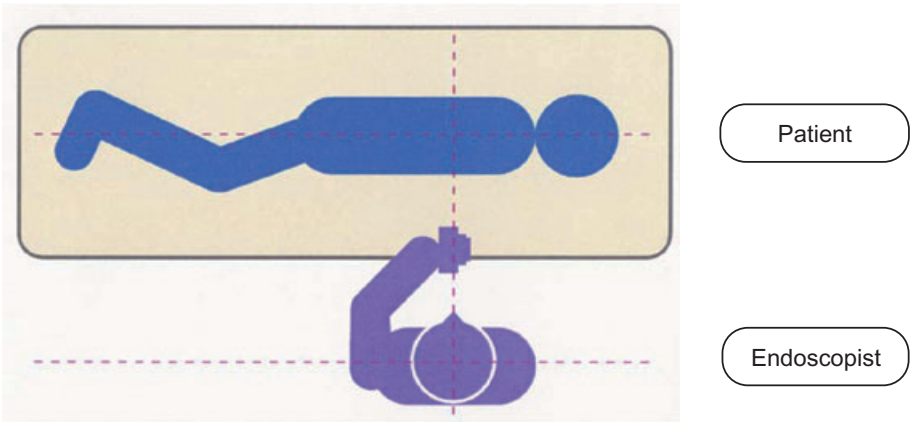
Scanning Position	Landmarks	Tips
Descending part of duodenum	Abdominal aorta IVC Superior mesenteric artery/vein Pancreatic head Papilla of Vater Bile duct Right kidney	Straighten the scope in the same way as ERCP (pull technique), and then observe while withdrawing from the distal to proximal duodenum.

■ Stomach, duodenal bulb and descending part of duodenum



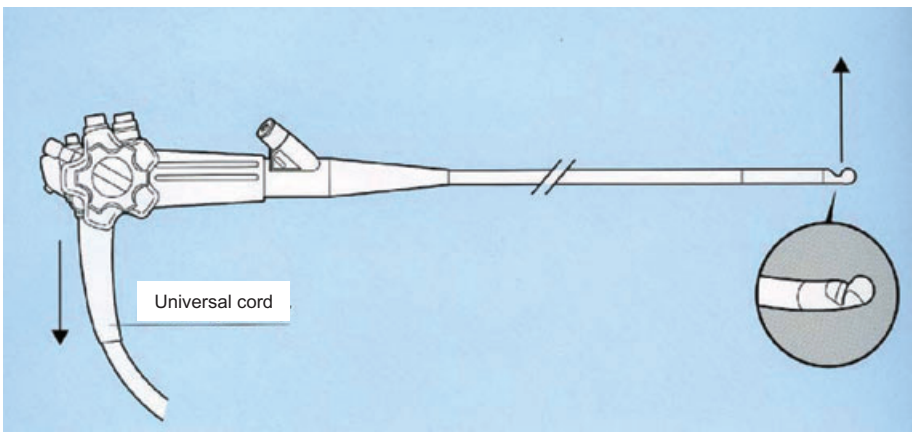
■ Positioning of the endoscopist and orientation of the echoendoscope

The orientation of the images in this handbook are with the endoscopist facing the patient, and with the scope handle oriented orthogonally to the patient's body.

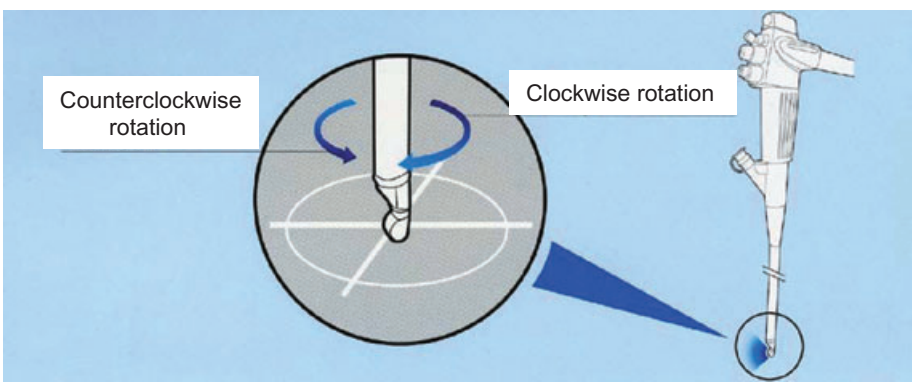


■ Rotating the curved linear array echoendoscope

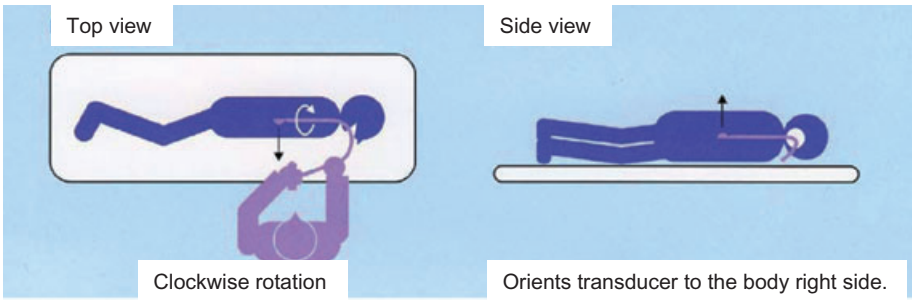
To correctly identify the position relationships of the surrounding organs, observation should generally be performed while the scope is straightened. In the stretched condition, the transducer is oriented towards the direction opposite to the universal cord.



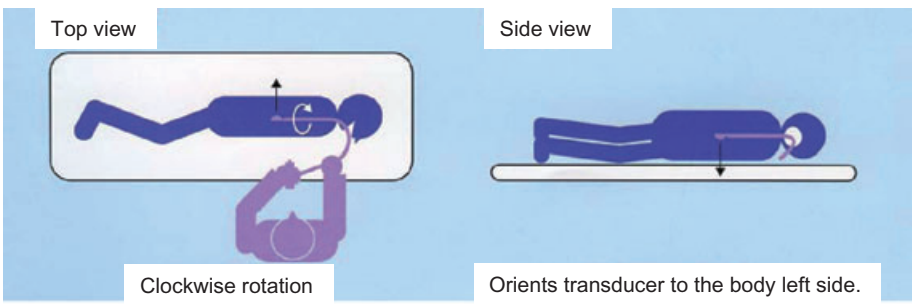
Rotation of the curved linear array echoendoscope is the key maneuver for complete imaging of targets. The illustrations below show the effect of clockwise and counterclockwise rotation of the scope.



When the transducer is oriented anteriorly toward the abdominal wall, rotate the scope clockwise to observe the right side of the body or counterclockwise to observe the left side.



When the transducer is oriented toward the back, rotate the scope clockwise to observe the left side of the body or counterclockwise to observe the right side.

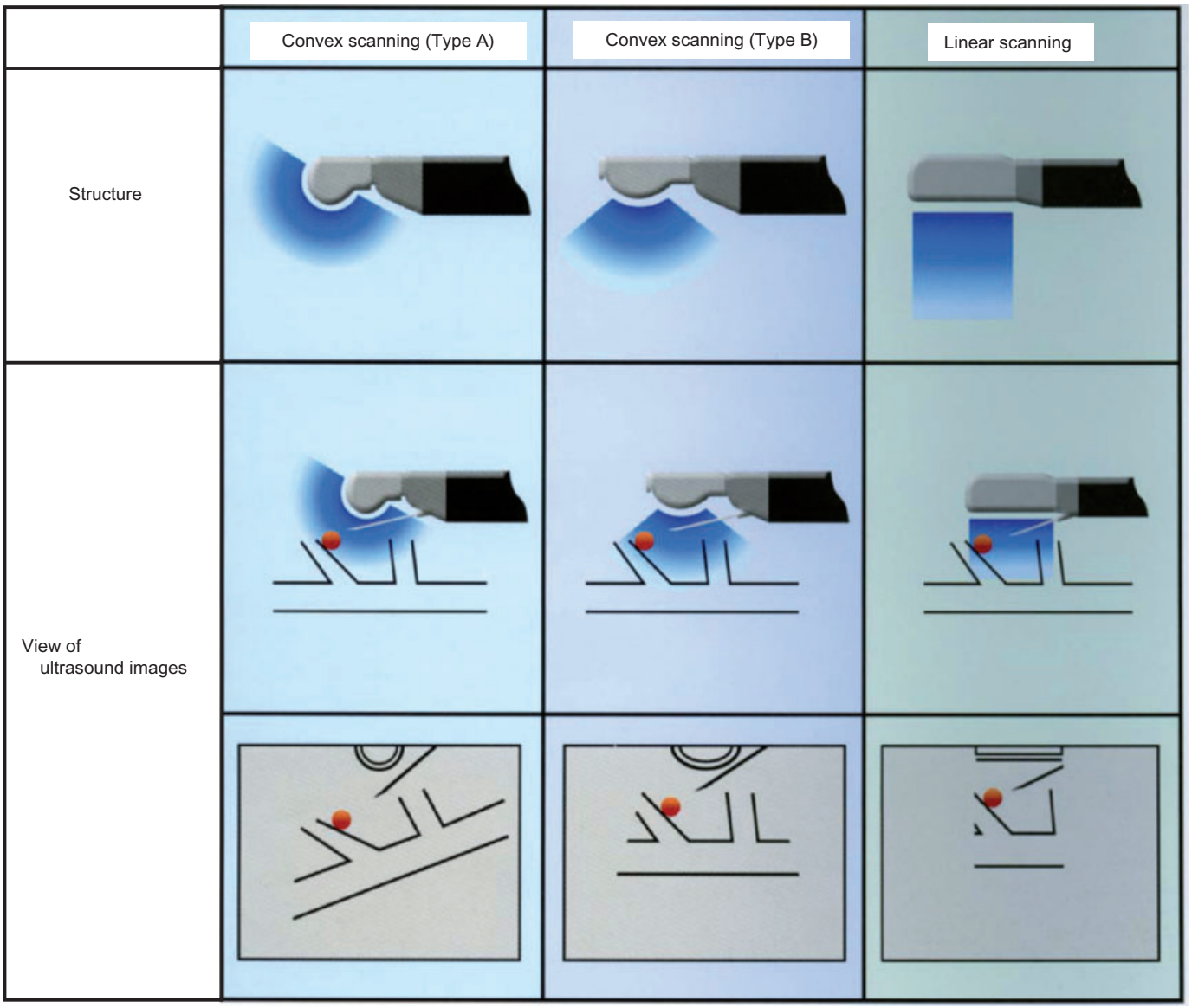


The descriptions above will help you determine whether the transducer is oriented anteriorly towards the abdominal wall or back.

2. View of Ultrasound Images

■ Convex scanning and linear scanning

This section describes the difference in views depending on the scanning method. Presently, ultrasonic endoscopes from various manufacturers are capable of fine-needle aspiration. The scanning methods used can be divided into the following three types.

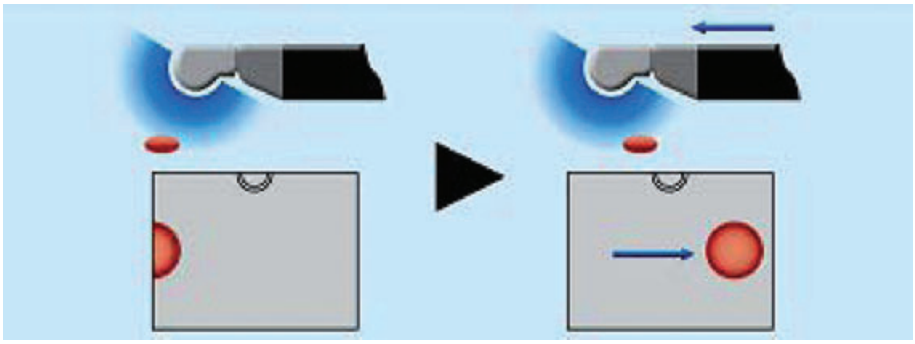


■ The reason why radial scanning is unsuitable for fine-needle aspiration.

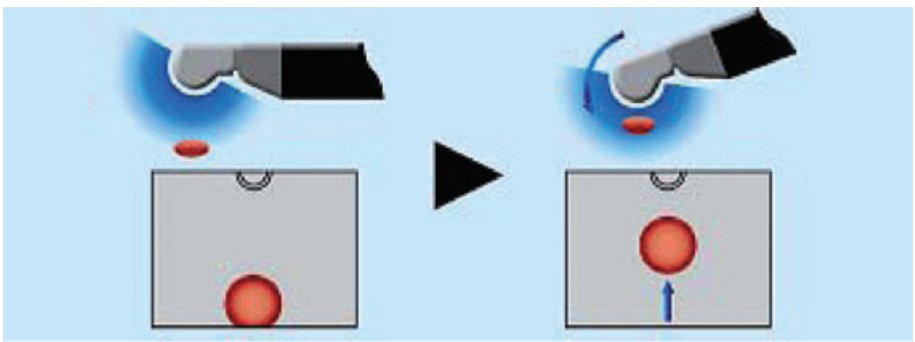
Radial-scanning EUS examination cannot visualize the needle path because the plane of scanning is perpendicular to the shaft of the scope. This is why radial scanning is unsuitable for use in fine-needle aspiration.

■ Optimizing position for target puncture

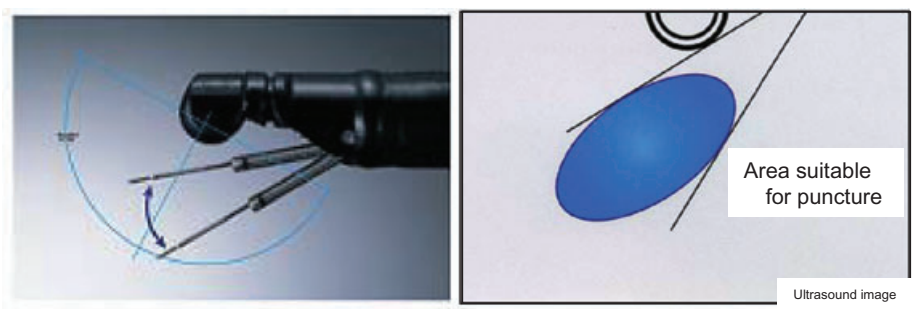
When the scope is advanced toward the left, the puncture target in the ultrasound image moves toward the right.



The transducer is attached at the scope's distal end so that the transducer orients toward the upward angulation direction of the scope (i.e. on the opposite side to the universal cord). When the scope is angulated upward, the transducer approaches the puncture target and the target in the ultrasound image moves upward.

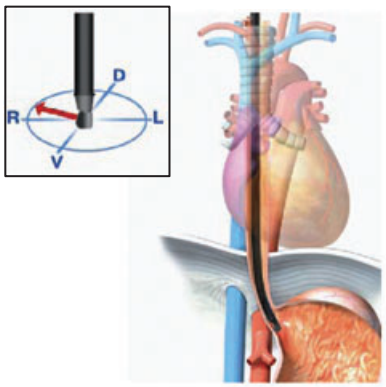


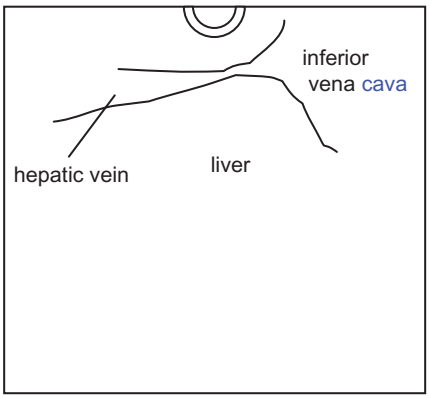
It is important that the target of endoscopic ultrasound-guided fine-needle aspiration is positioned in the area shown below. To improve the stability of puncture, move the scope to and fro and angulate it upward so that the target is imaged in this area.



3. Procedure - Scanning from the esophagus -

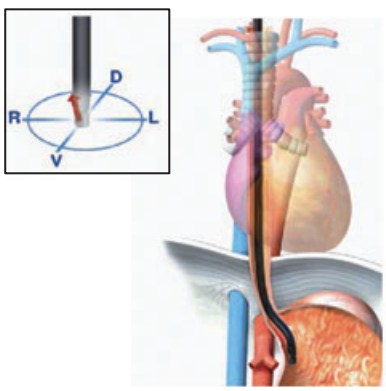
■Step 1

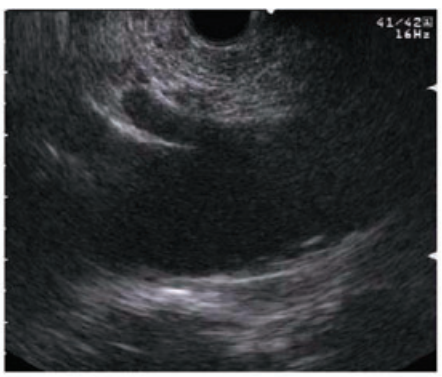


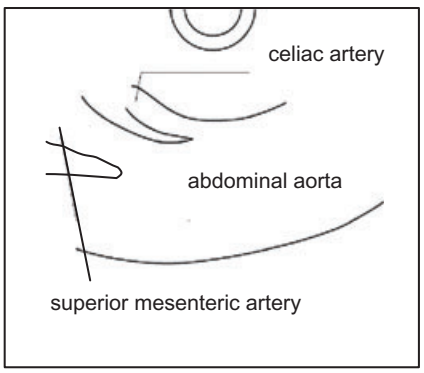


When the scope is inserted into the stomach past the EG junction with the controls free, the left lobe of the liver is visible on the screen below the scope. Now rotate the scope clockwise to visualize the hepatic vein and the IVC.

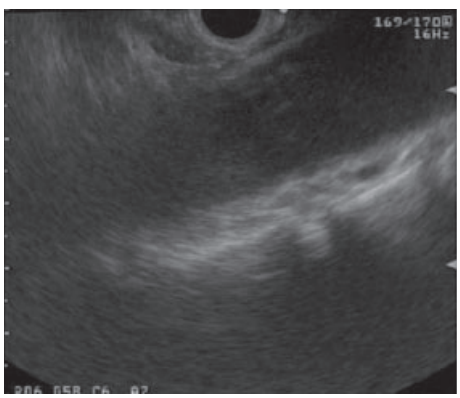
■Step 2

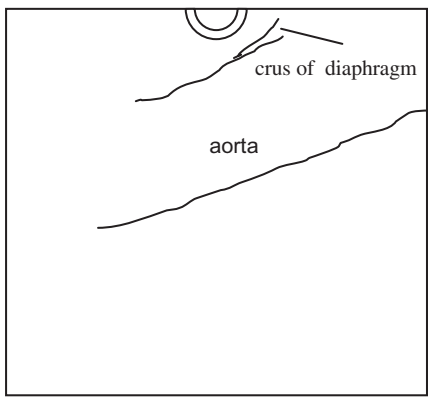






After observing the liver, rotate the scope clockwise to observe the abdominal aorta. Then advance the scope slightly until the celiac artery bifurcation and superior mesenteric artery are recognized. Observe the lymph nodes around the celiac artery from this position.

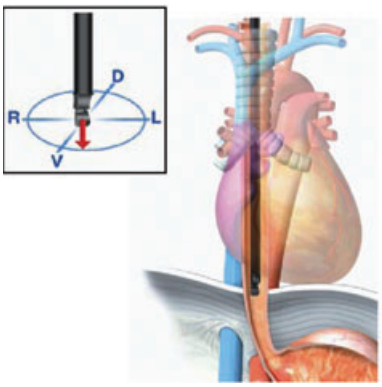


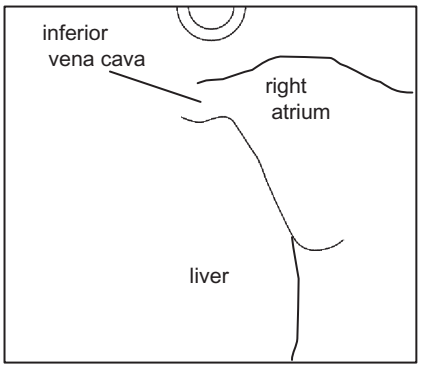


While observing the aorta, withdraw the scope slightly while rotating it counterclockwise, until a long triangular hypoechoic structure is seen in front of the aorta. This is the crus of the diaphragm, which is an important landmark for defining the boundary between the abdominal cavity and mediastinum. After evaluating this region, withdraw the scope while viewing the aorta to observe the surroundings of the thoracic aorta. When the scope is rotated counterclockwise after observing the crus of the diaphragm, it returns to the positioning in Step 1.

3. Procedure - Scanning from the esophagus -

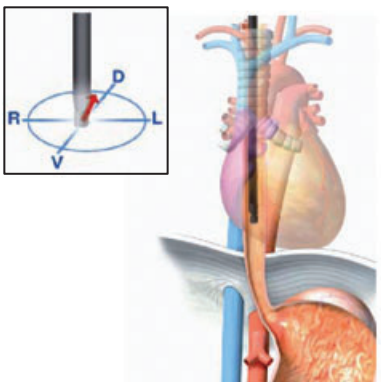
■Step 3

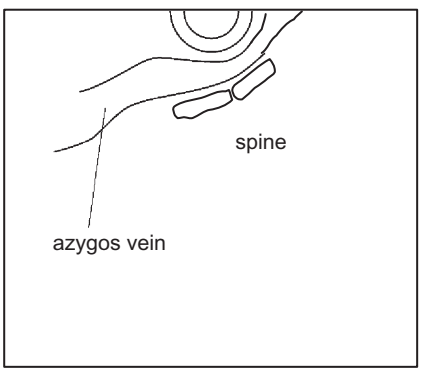




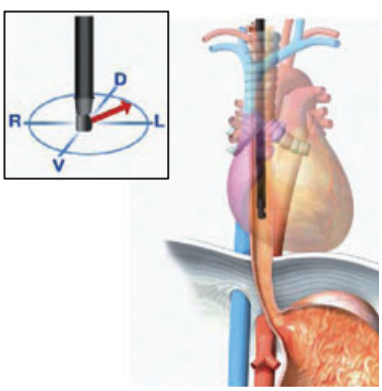
After observing the IVC, withdraw the scope to observe the right atrium.

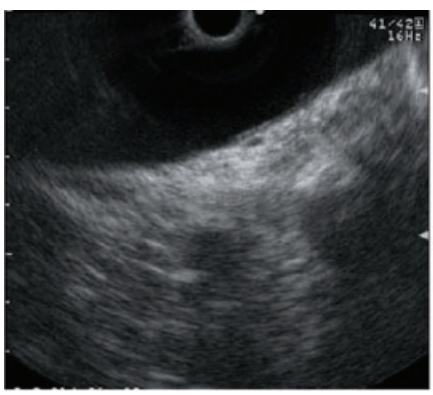
■Step 4

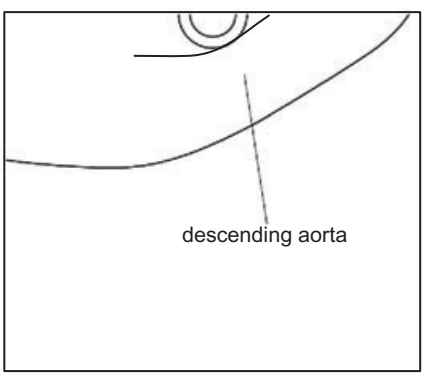




Rotate the scope clockwise to observe the entire surroundings of the esophagus. Then withdraw the scope slightly until the azygos vein is identified. Trace the azygos vein in both longitudinal directions toward the caudal and oral sides, and look for any adjacent lymph nodes.



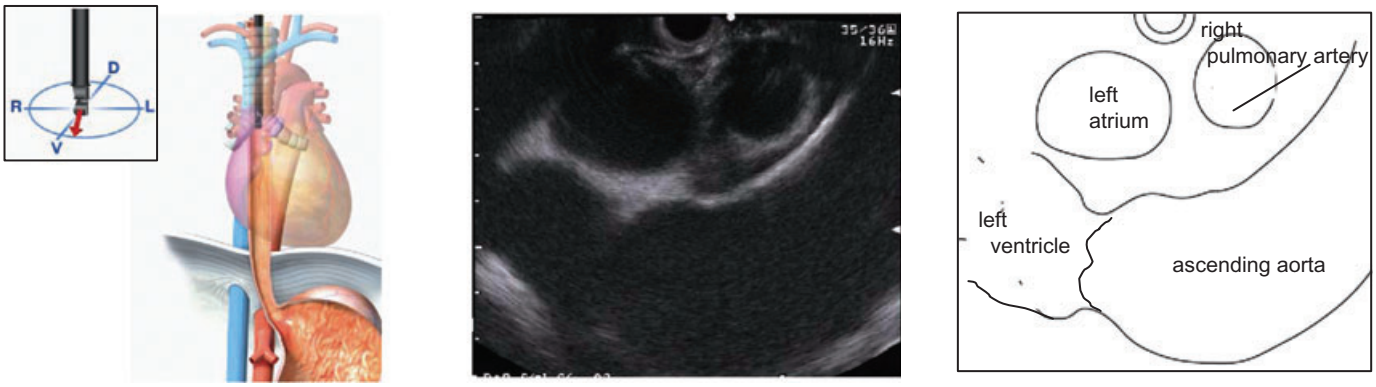




Rotate the scope further clockwise to observe the descending aorta also. Trace the descending aorta longitudinally towards both the caudal and oral directions, and look for any adjacent lymph nodes.

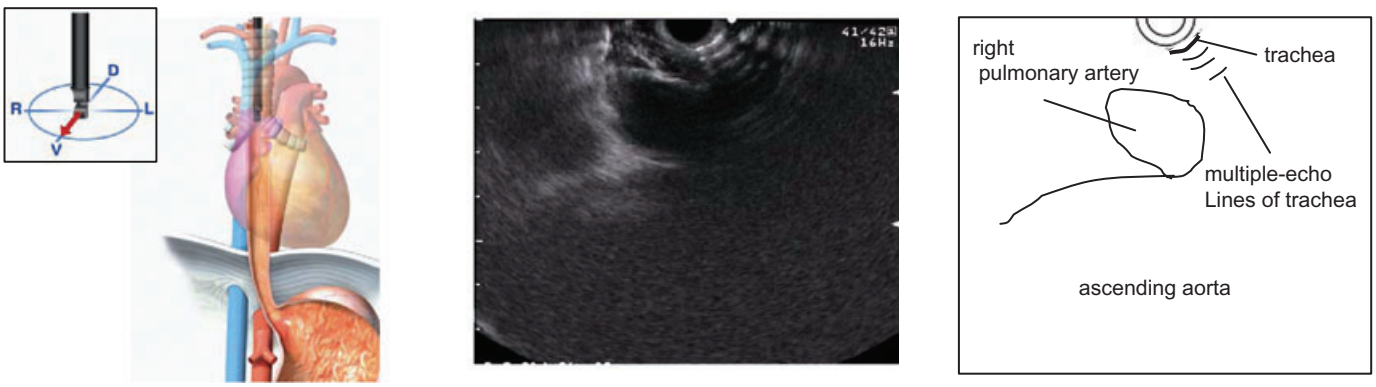
3. Procedure - Scanning from the esophagus -

■Step 5



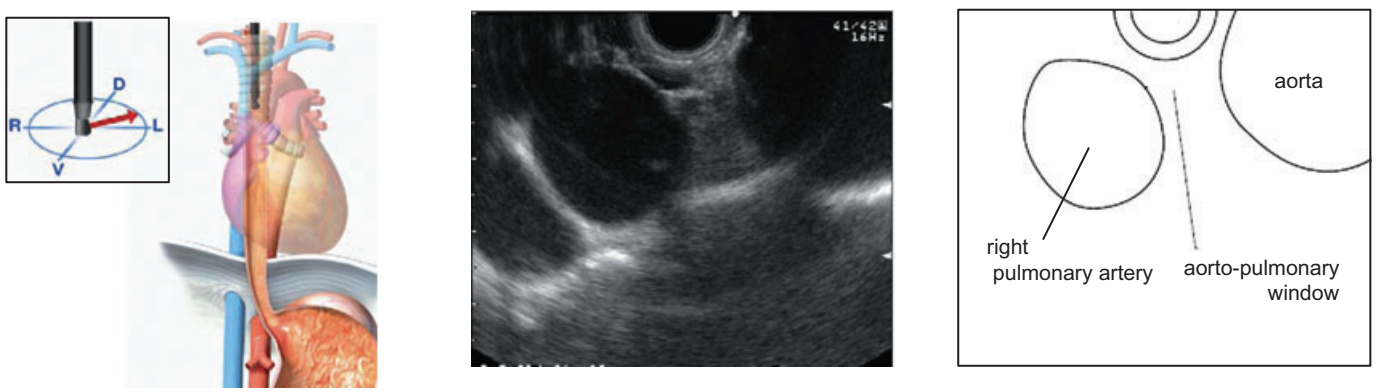
Rotate the scope counterclockwise to return to the positioning in Step 3, and withdraw the scope while rotating it further counterclockwise to visualize the left atrium, left ventricle, ascending aorta and right pulmonary artery.

■Step 6



While watching the right pulmonary artery, withdraw the scope while rotating it slightly counterclockwise to visualize the trachea or main bronchi. The point towards the oral side (right in the image) where the multiple-echo lines end, is the tracheal bifurcation into the left and right main bronchi. If imaging of this point is difficult, trace the multiple-echo lines from the oral side to the point where these are interrupted.

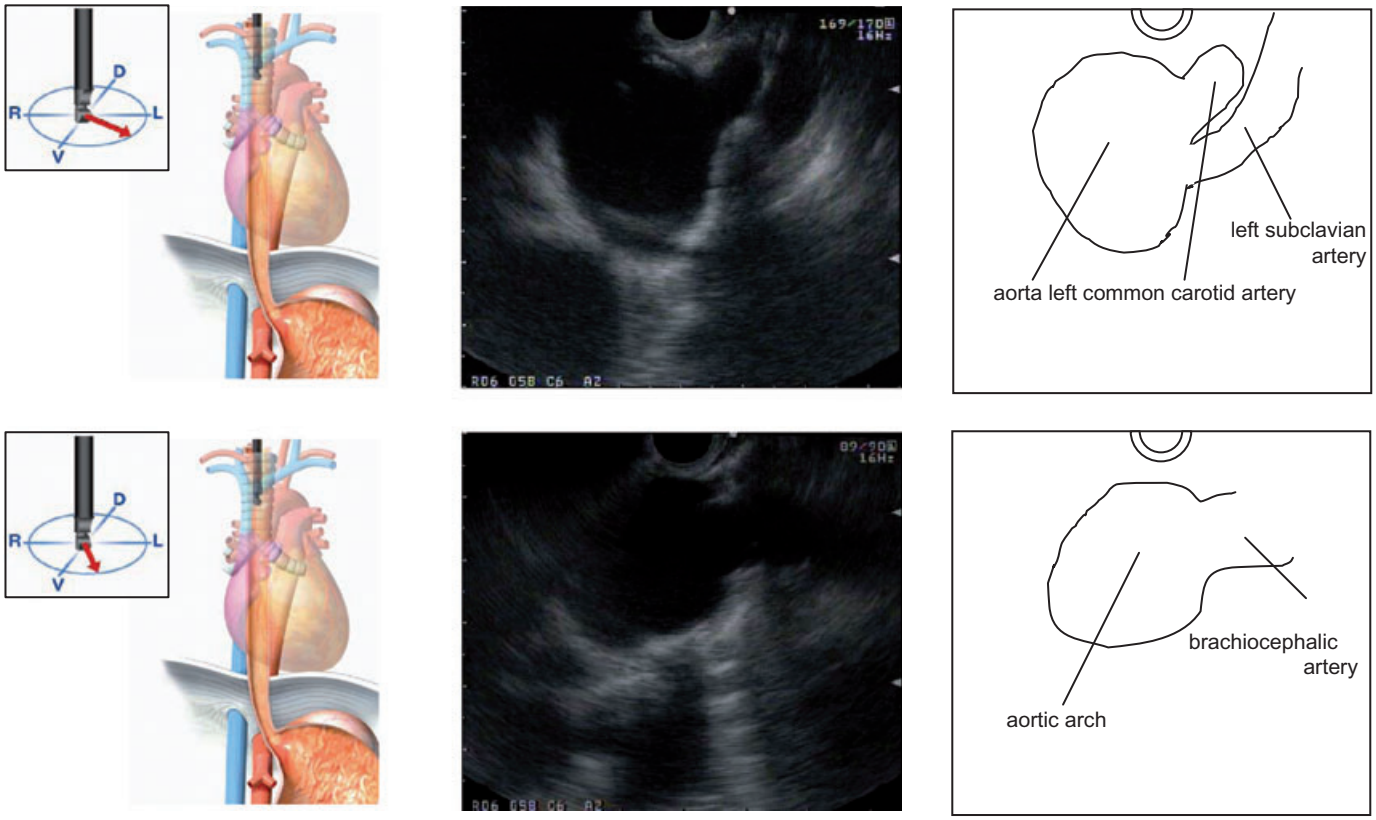
■Step 7



Visualize the right pulmonary artery again, and withdraw the scope while rotating it counterclockwise to visualize the right pulmonary artery on the left side in the image and the cross-section of the aortic arch on the right side. The region between the two blood vessels is the aorto-pulmonary window (AP window).

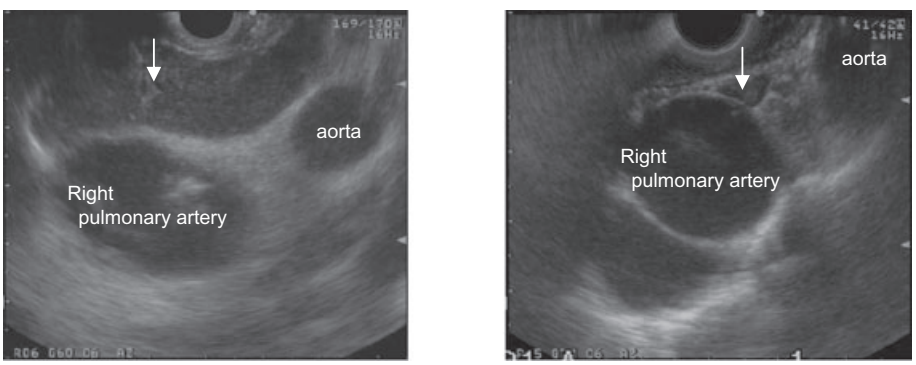
3. Procedure - Scanning from the esophagus -

■Step 8



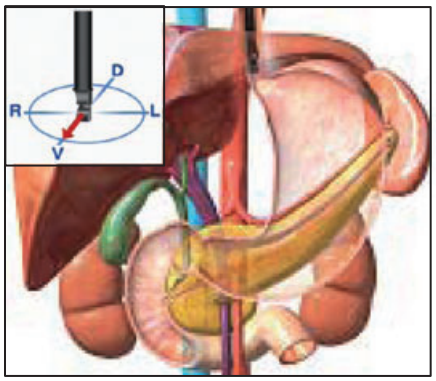
While observing the aortic arch, withdraw the scope while rotating it counterclockwise to visualize the left subclavian artery and left common carotid artery. Rotating the scope further counterclockwise at this level makes it possible to observe the brachiocephalic artery.

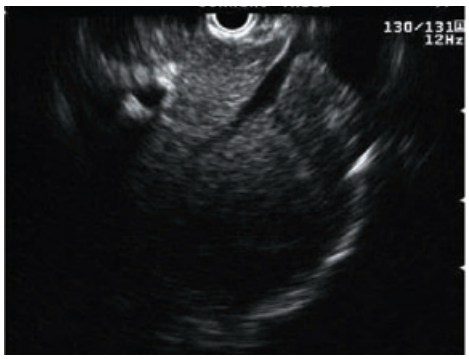
* Lymph nodes around tracheal bifurcation and AP window

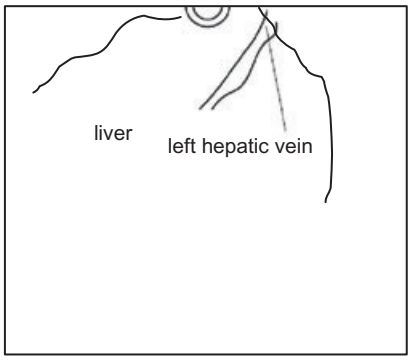


3. Procedure - Scanning from the stomach -

■Step 1

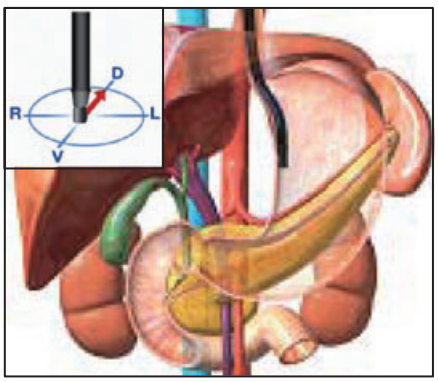


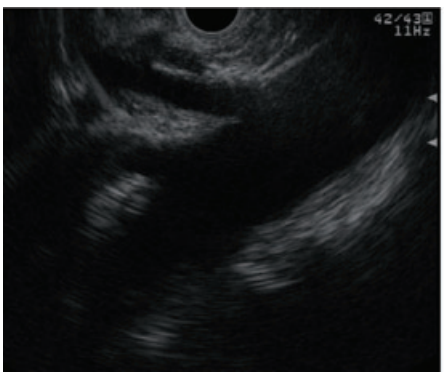


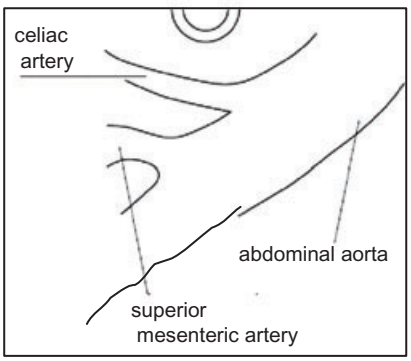


With the patient lying in the left lateral position, the (outer region of the) left lobe of the liver is imaged after the scope has passed the diaphragm. The transducer is now oriented anteriorly toward the abdominal wall of the patient. The left hepatic vein is also observed from this position.

■Step 2

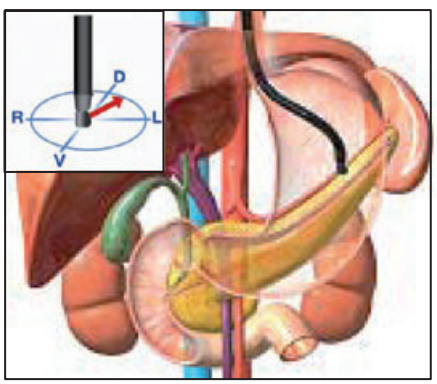


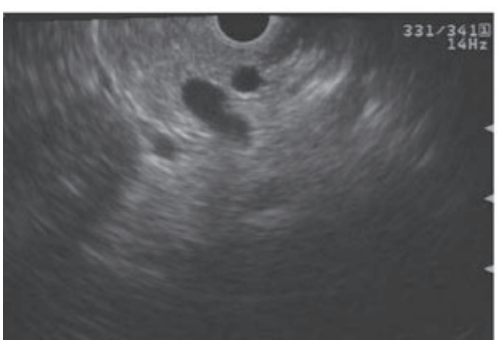


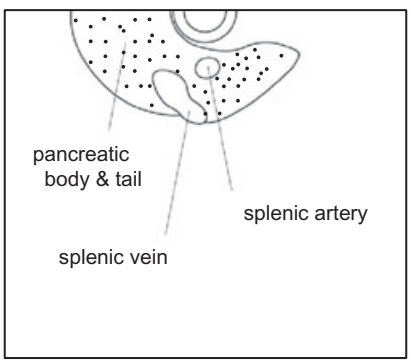


Rotate the scope clockwise to visualize the abdominal aorta. When the scope is advanced caudally from this position along the abdominal aorta, the celiac artery and superior mesenteric artery are imaged. Note that the celiac artery and superior mesenteric artery are not always imaged simultaneously. The celiac artery is usually easier to image. It is therefore recommended to visualize the celiac artery first and then rotate the scope slightly clockwise or counterclockwise to identify the superior mesenteric artery.

■Step 3



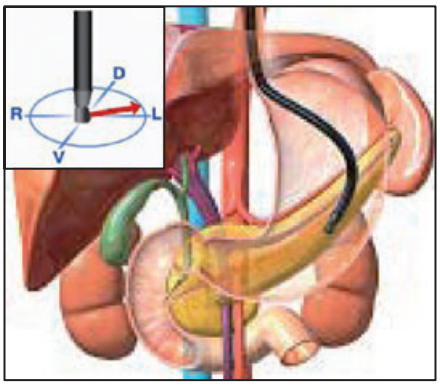


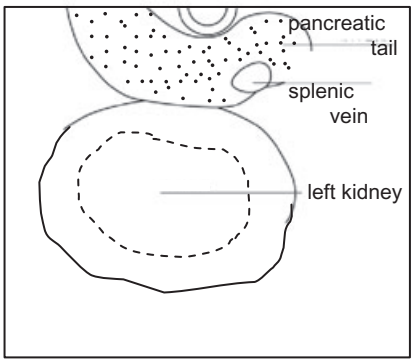


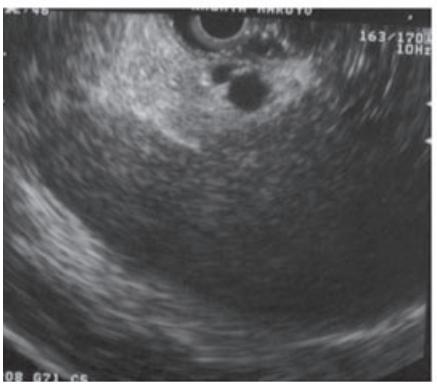
Advance the scope slightly and rotate it clockwise to visualize the pancreatic body and tail. In general, the splenic artery is imaged nearer and splenic vein farther from the transducer. The splenic artery and vein can be discriminated by means of color and pulse Doppler.

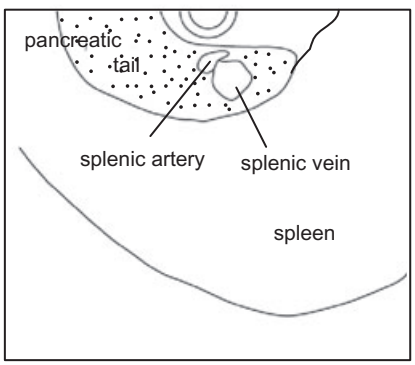
3. Procedure - Scanning from the stomach -

■Step 4

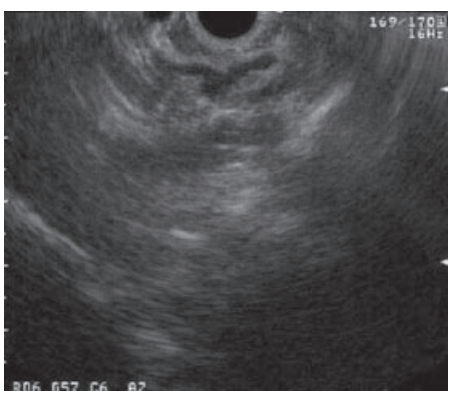


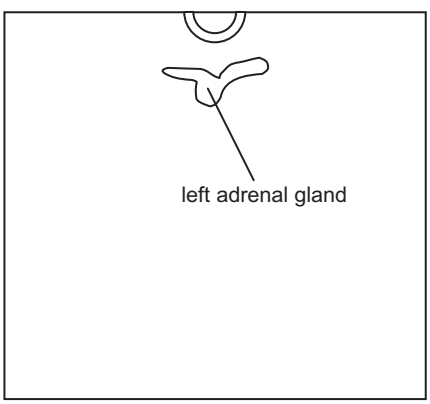






While imaging the spleen by using the splenic vein as the landmark, rotate the scope to visualize the pancreatic tail and left kidney. Rotate the scope further to observe the pancreas until the splenic hilum.

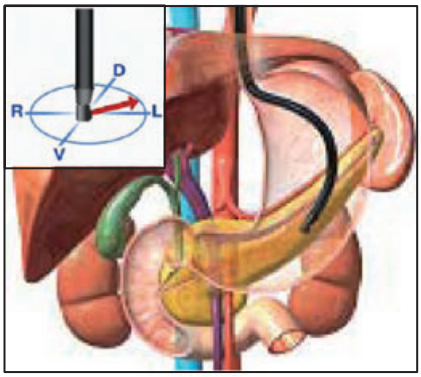


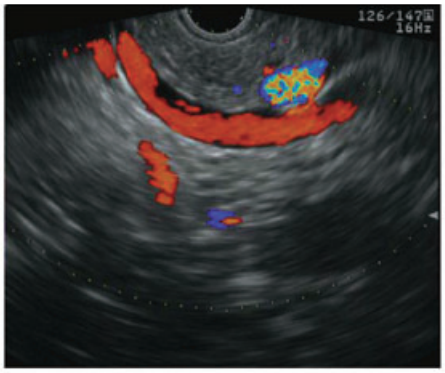


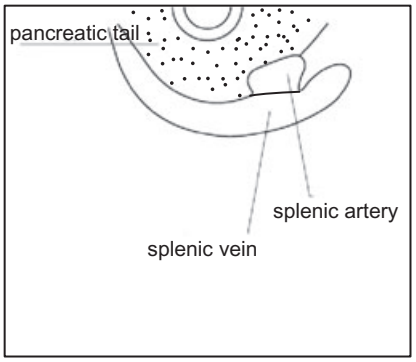
From the above position, advance the scope to observe the left adrenal gland, which is located between the abdominal aorta and upper pole of the left kidney.

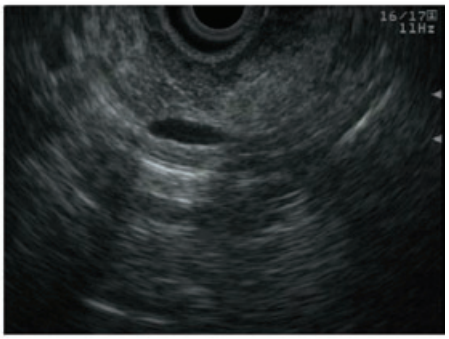
3. Procedure - Scanning from the stomach -

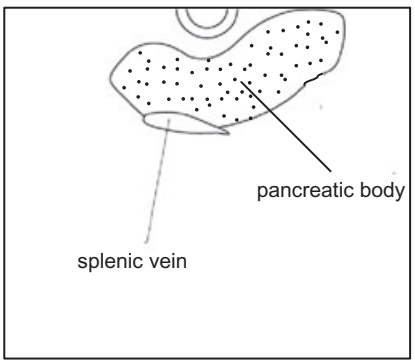
■Step 5

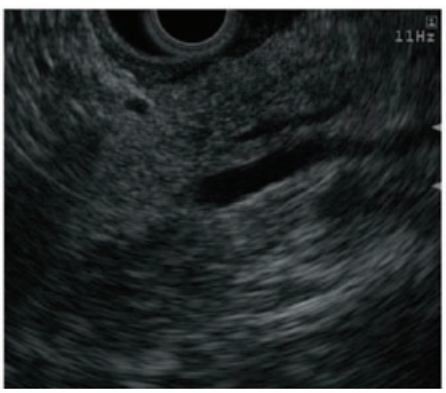


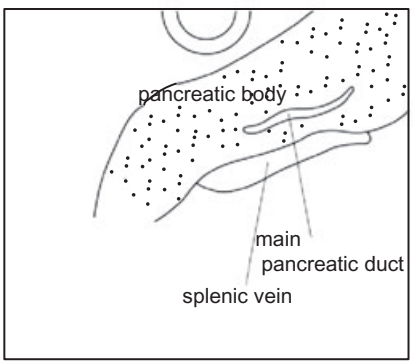








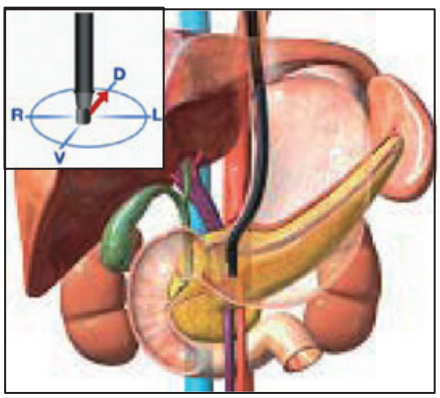


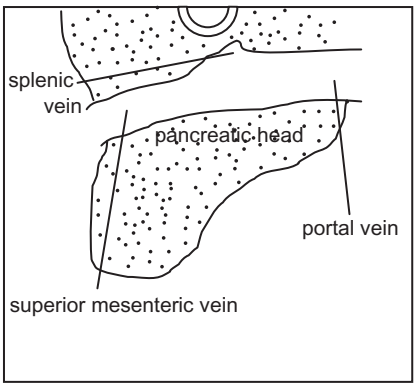


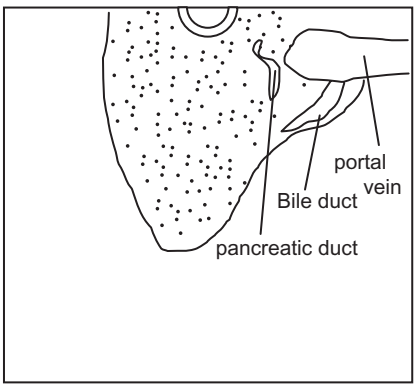
After identifying the splenic hilum, advance the scope while rotating it counterclockwise little by little to observe the pancreas from the tail toward the body. If distinguishing between the splenic artery and splenic vein is difficult, the Doppler mode should be used. Observe the pancreas continuously from the tail to the body.

3. Procedure - Scanning from the stomach -

■Step 6



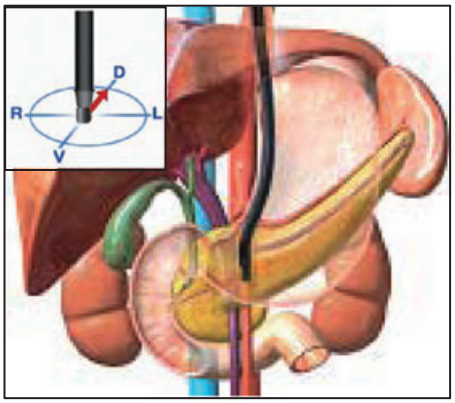


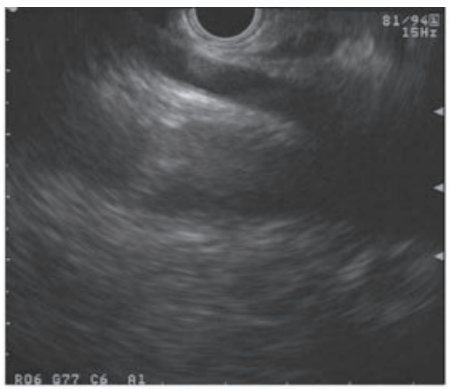


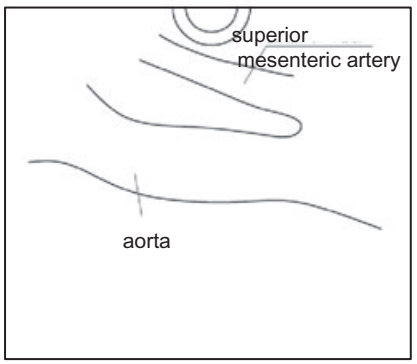
When the splenic vein is traced, the confluence between the superior mesenteric vein and portal vein can be observed. In this position, part of the pancreatic head is also imaged. When the scope is rotated counterclockwise at the portal confluence, the junction between the pancreatic head and body, the main pancreatic duct, and the bile duct can also be observed.

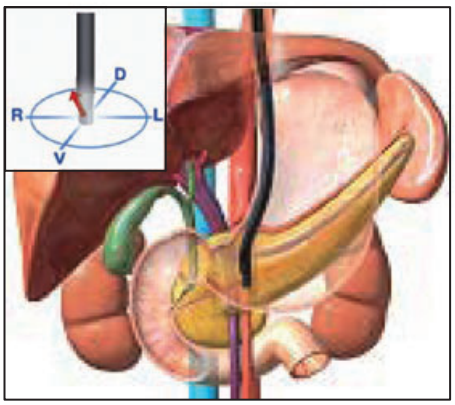
3. Procedure - Scanning from the stomach -

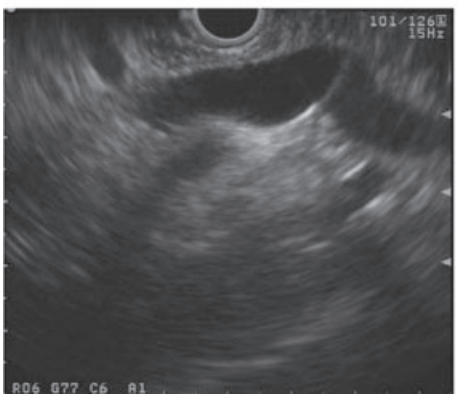
* In case of difficulty in tracing the splenic vein to the portal vein confluence

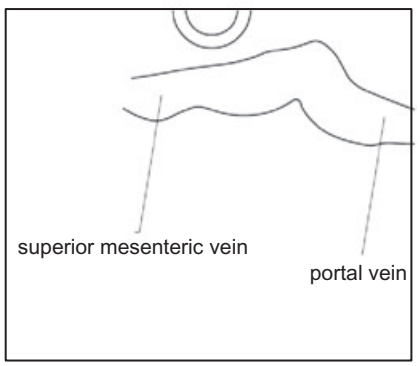








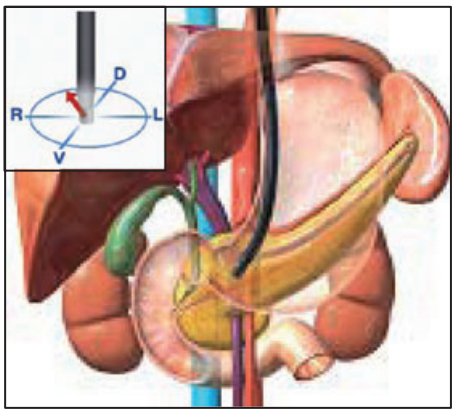


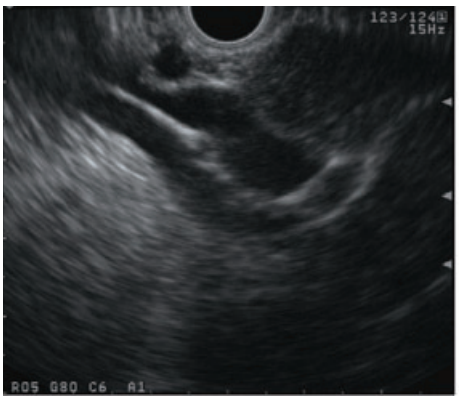


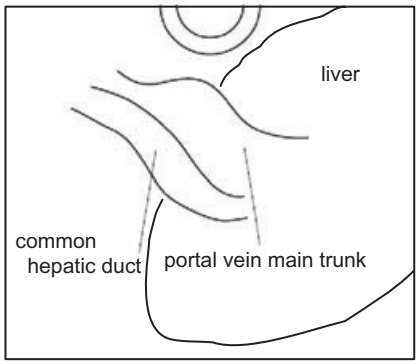
After imaging the superior mesenteric artery from the gastric body, rotate the scope counterclockwise to visualize the superior mesenteric vein that is running parallel to the superior mesenteric artery. Manipulate the scope to visualize the superior mesenteric vein in the longitudinal direction, and then withdraw the scope gradually to observe its junction with the main trunk of the portal vein.

3. Procedure - Scanning from the stomach -

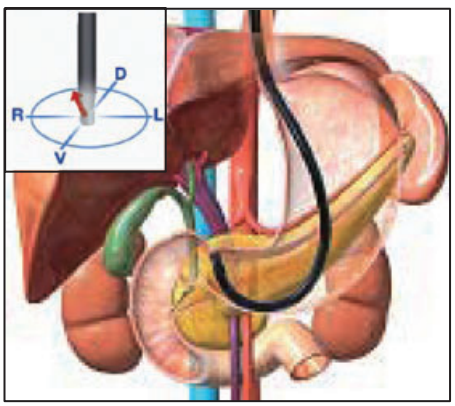
■Step 7

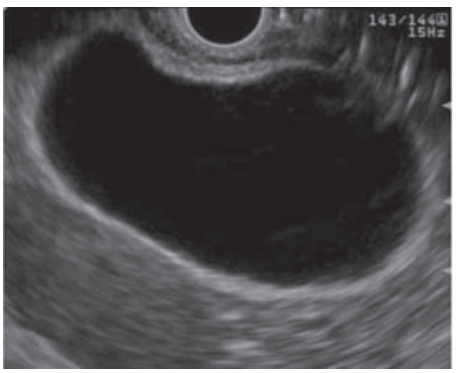


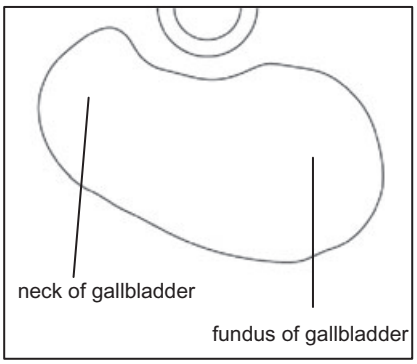




After imaging the main trunk of the portal vein, withdraw the scope to trace the portal vein toward the liver. This makes it possible to observe the hilum of the liver.



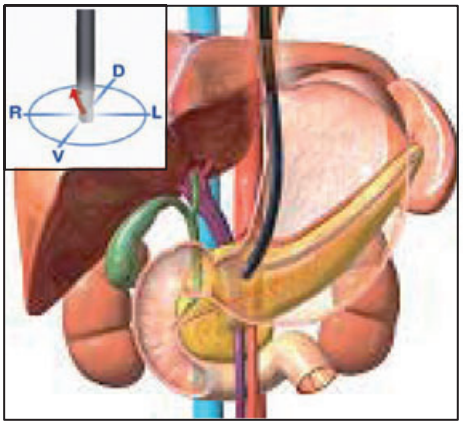


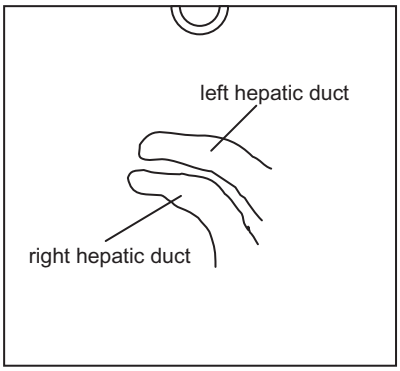


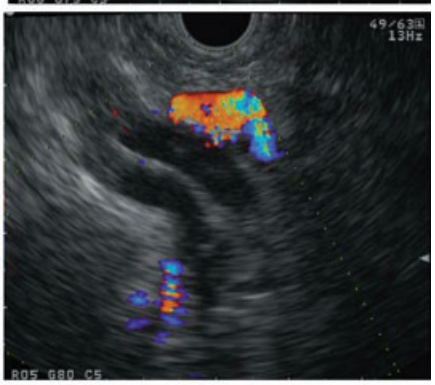
When the scope is pushed in, the gallbladder can be imaged from the antrum.

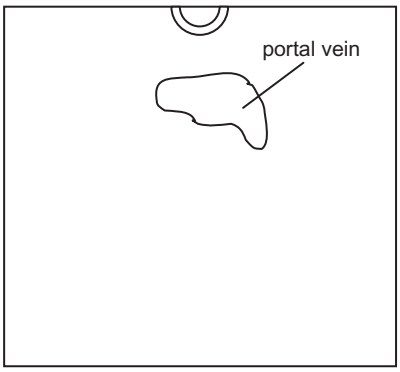
3. Procedure - Scanning from the stomach -

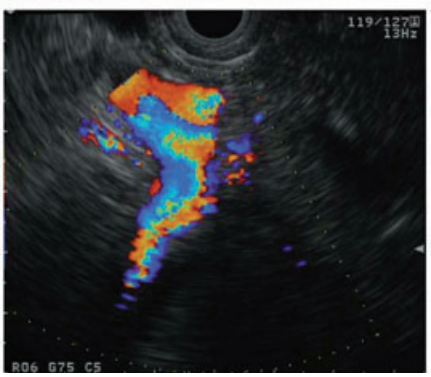
* Imaging of the hilum of the liver

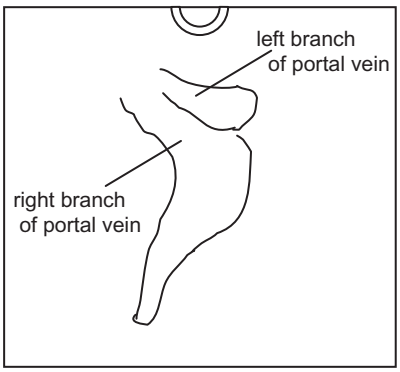








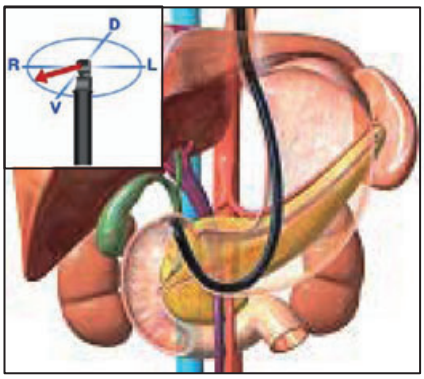


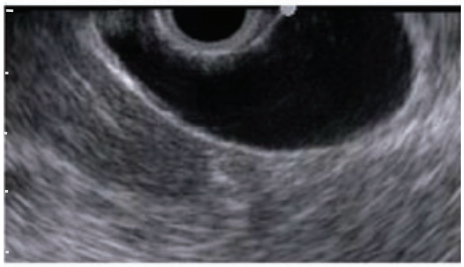


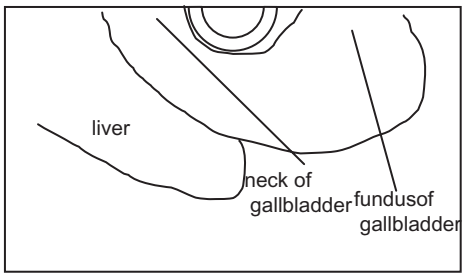
When the scope is withdrawn from the position in Step 7, the left and right hepatic ducts are imaged. Turning the scope counterclockwise may sometimes move the right hepatic duct image to the bottom and turning it clockwise may sometimes visualize the left hepatic duct.

3. Procedure - Scanning from the duodenal bulb -

■Step 1

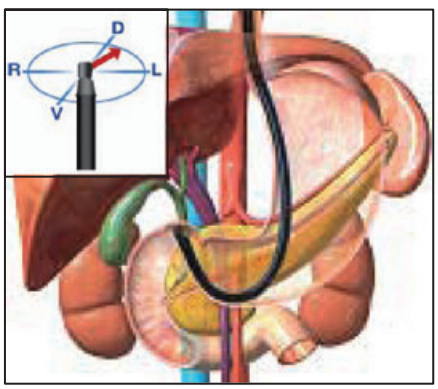


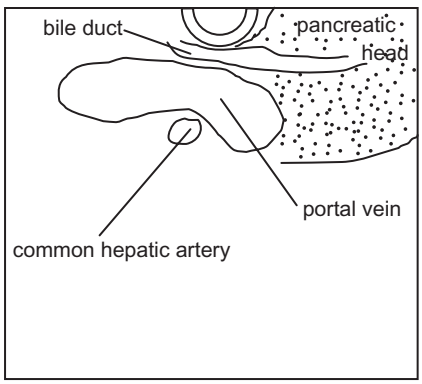




Insert the scope into the duodenal bulb and rotate the scope counterclockwise to visualize the gallbladder. The neck lies on the left side of image and the fundus lies on the right side.

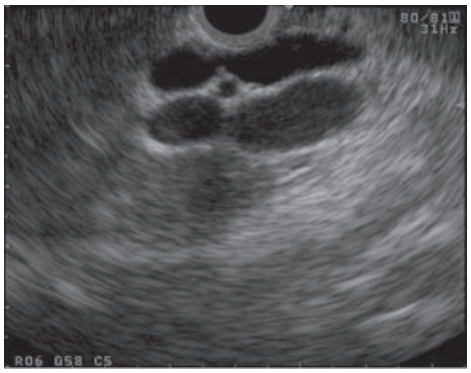
■Step 2

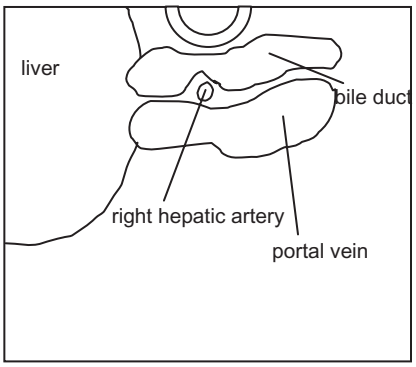




Rotate the scope clockwise to visualize 3 luminal structures. The portal vein, bile duct and common hepatic artery can be identified using Doppler as required.

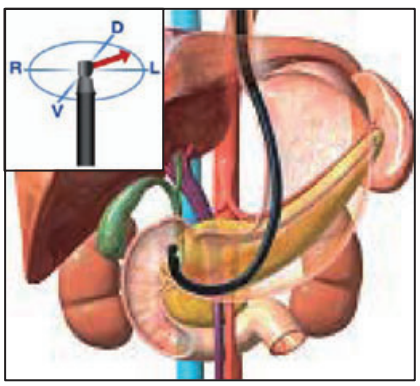
3. Procedure - Scanning from the duodenal bulb -

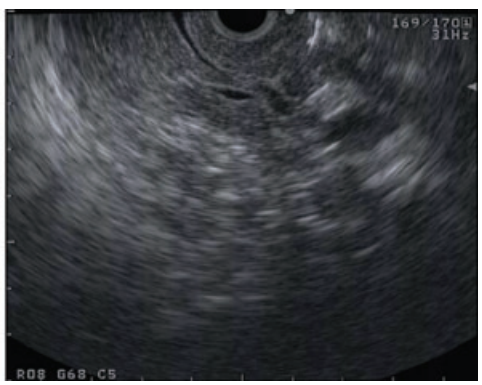


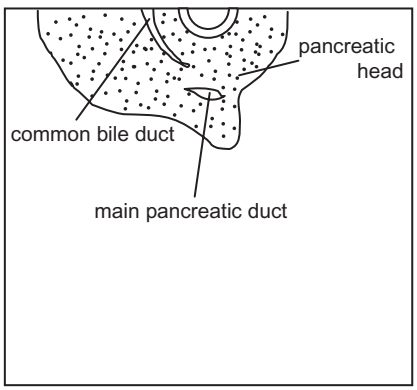


Advance the scope slightly from this position and rotate it counterclockwise to visualize the portal vein, bile duct and right hepatic artery. At this time, the transducer is directed cranially.

■Step 3



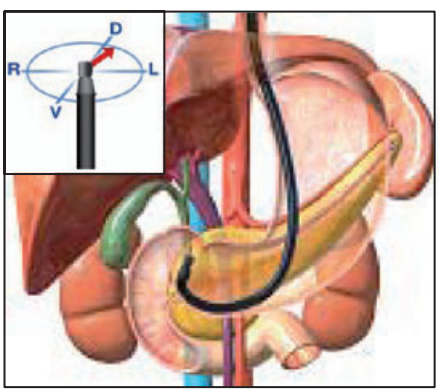


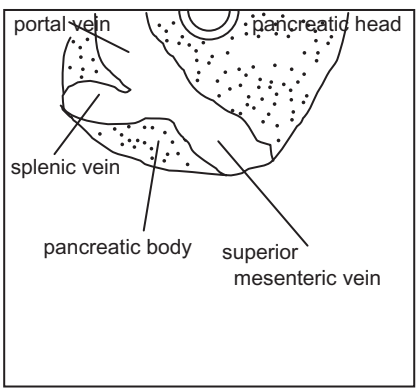


While rotating the scope clockwise, trace the imaged bile duct toward the papilla to visualize the bile duct and main pancreatic duct near the papilla.

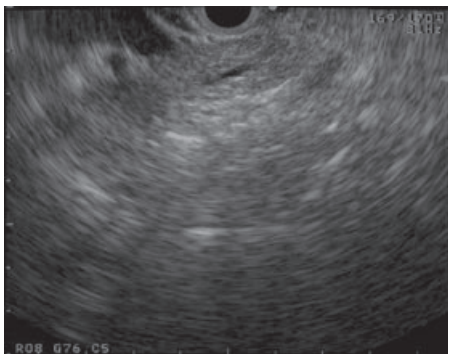
3. Procedure - Scanning from the duodenal bulb -

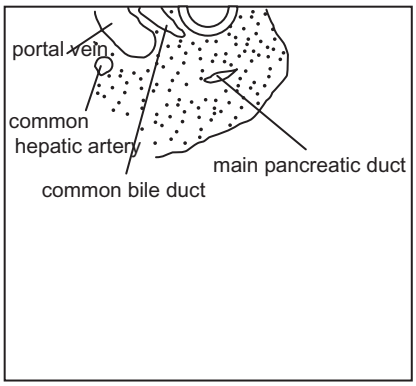
■Step 4





Continue imaging along the portal vein to visualize the confluence between the portal vein, splenic vein and superior mesenteric vein. The pancreatic head and body can also be observed from the duodenal side.

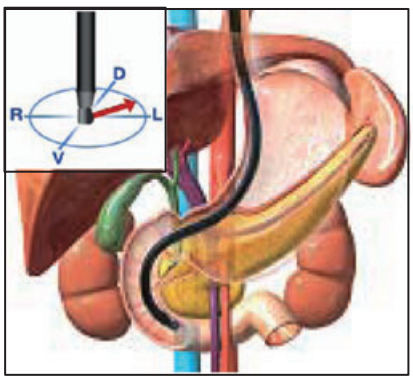


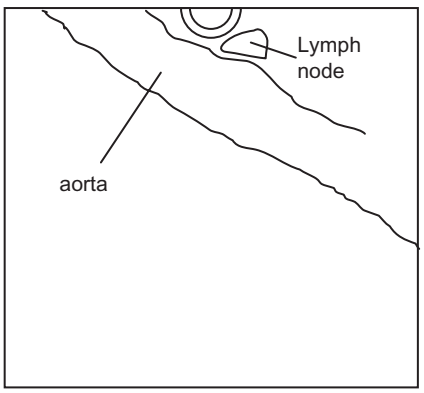


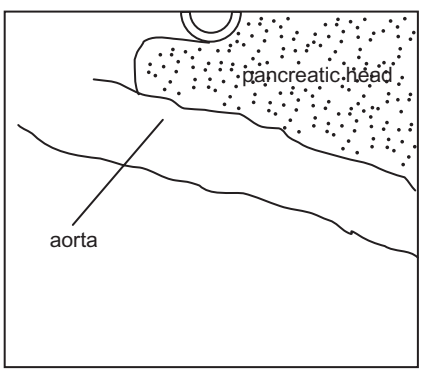
Rotate the scope counterclockwise to visualize the pancreatic head and body.

3. Procedure - Scanning from the Descending Part of Duodenum -

■Step 1



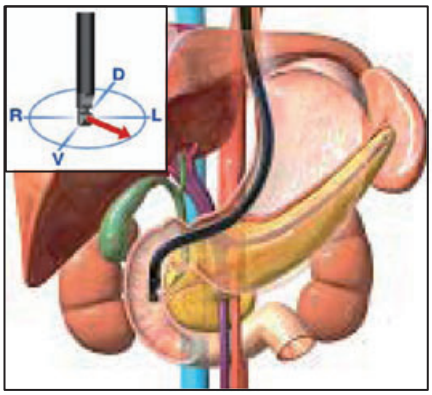


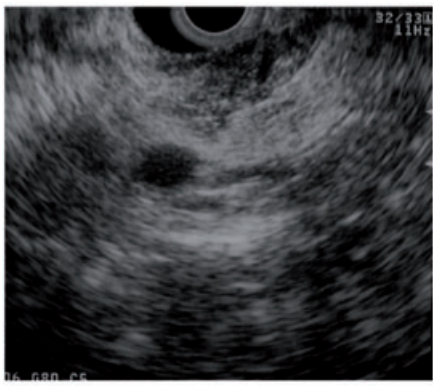


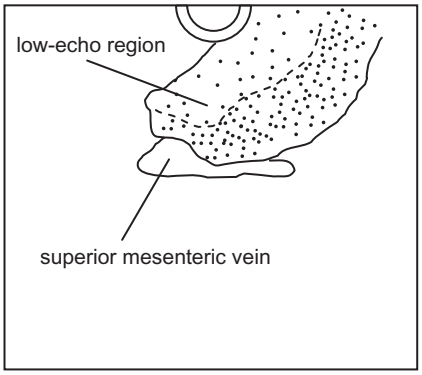
Insert the scope into the descending part of the duodenum and straighten it before starting observation. Rotate the scope clockwise to visualize the aorta and IVC. While imaging the aorta, withdraw the scope slowly to visualize the lower part of the pancreatic head. The aorta gradually lines up parallel with the image, and the pancreatic head will be imaged between the aorta and transducer.

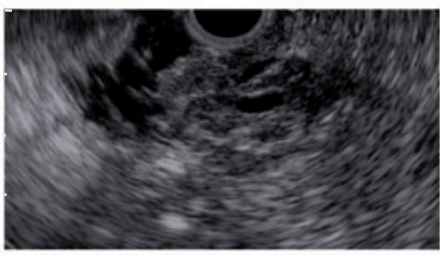
3. Procedure - Scanning from the Descending Part of Duodenum -

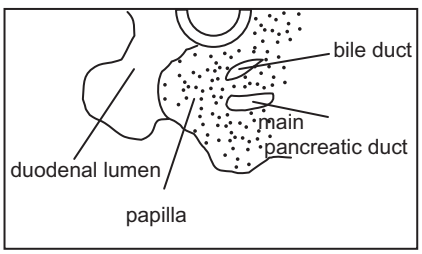
■Step 2

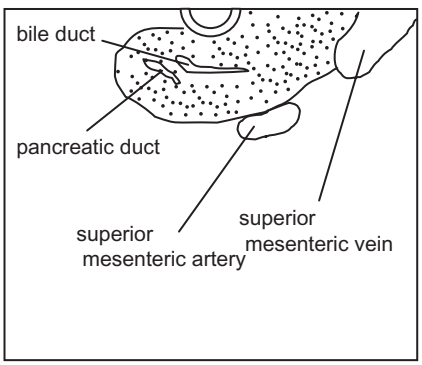












While observing the pancreatic parenchyma, withdraw the scope slowly to image a low-echo region near the transducer. Rotate the scope slightly clockwise and counterclockwise to identify two luminal structures in the low-echo region. The bile duct is imaged near the transducer and the main pancreatic duct is imaged on a farther point.

Note: For detailed observation of the papilla, inject de-aerated water into the duodenum.

3. Procedure - Scanning from the Descending Part of Duodenum -

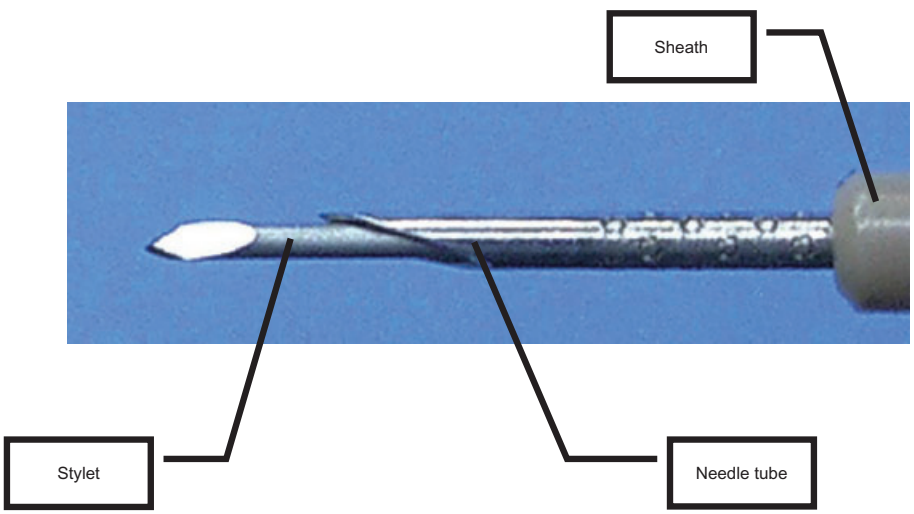
* Imaging of right kidney

The right kidney may sometimes be imaged from the descending part of the duodenum.

4. Endoscopic Ultrasound-Guided Fine-Needle Aspiration Procedures

■ Aspiration needle

Aspiration needles from various manufacturers are available for use in endoscopic ultrasound-guided fine needle aspiration (EUS-FNA). The basic aspiration needle has a three-layer configuration composed of the needle tube, stylet, and sheath. FNA needles are available in 19, 21 and 22 gauges sizes. There are also special aspiration needles such as one with spring-assisted automatic puncture function and Trucut biopsy needles aiming at histologic diagnosis.

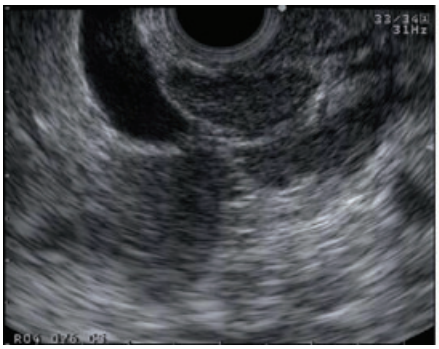


■ Preparation

Apply the same preparation as in ordinary endoscopic examinations. Before EUS-FNA, it is also required to check that the patient does not have any bleeding tendency, or is on anticoagulants. Also use sedation as required.

■ Aspiration technique

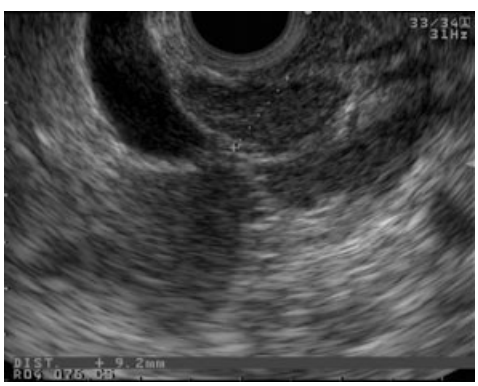
1: Before puncturing, visualize the lesion in the B-mode image of the ultrasonic endoscope and confirm the absence of intervening blood vessels by means of color Doppler.




2: Check the ultrasound image (arrow) or endoscopic image to confirm that the sheath of the aspiration needle is projecting from the instrument channel. If significant resistance is encountered when inserting the aspiration needle through the channel, adjust scope angulation until the aspiration needle can be easily inserted without drag. Check the insertion angle based on the echo image of the sheath or needle tube.

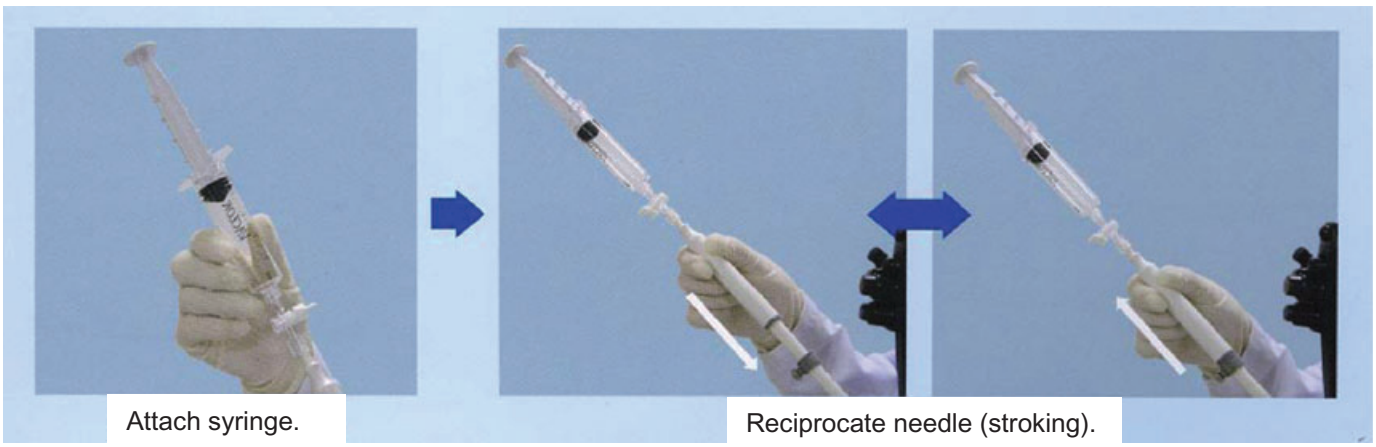
Note: Do not raise the forceps elevator too much, as this could bend the aspiration needle and move it away from the ultrasound-scanning plane, preventing it from being visualized in the ultrasound image.


3: Measure the distance from the projecting, distal end of the needle tube to the puncture target so that the aspiration needle does not overshoot beyond the puncture target.



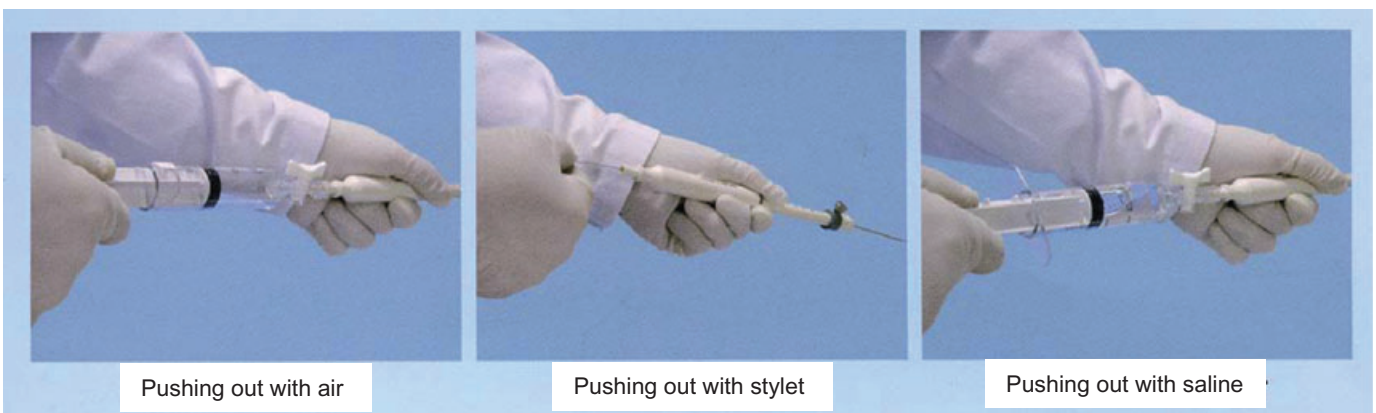
Note: With certain aspiration needles, it is helpful at this time to withdraw the stylet by about 5 mm as this may make it easier to visualize the tip of the aspiration needle with ultrasound. This procedure also makes the needle sharper and the insertion easier. After inserting the needle into the lesion, be sure to completely reinsert the stylet to clear the needle tip, before aspirating. This will prevent unnecessary contamination from gastrointestinal tract cells.

4: Withdraw the stylet completely, attach a syringe to the aspiration needle, apply negative pressure, and move the needle to and fro more than 10 times inside the lesion.



5: Remove the negative pressure, pull the needle tube back inside the sheath, and remove the aspiration needle from the scope.

6: The specimen can be pushed out from the needle sheath by reinserting the stylet or flushing it with air or saline.



7: Submit the specimens for cytology and cell block preparation for histology.

8: Post-procedure monitor the patient for any adverse events (bleeding, perforation, pancreatitis, infection, etc.)

Note 1. Method with no aspiration, aspiration at lower pressure, or fewer strokes may also be used when puncturing lymph node, etc.
Note 2. When a cytotechnician or pathologist is able to attend in the examination room, a quick cytodiagnosis (Diff-Quik staining or Cyto-Quik staining) to confirm that a sufficient amount of sample has been obtained.

_!_ Be sure to read the documents and manuals provided with the product before use.