Imaging of infracolic and pelvic compartment by linear EUS

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ABSTRACT

The peritoneal cavity is subdivided into supracolic and infracolic compartments by transverse mesocolon, which attaches the colon to the posterior abdominal wall. Infracolic compartment is subdivided into right and left compartment by small bowel mesentery. Left infracolic space freely communicates with pelvic compartment. The infracolic compartment contains the coils of small bowel which is separated from paracolic gutter on either side by ascending and descending colon. Pelvic compartment mainly contains bladder, rectum and genital organ (prostate, seminal vesicle in male and uterus in female). The evaluation of different compartments of peritoneum is gaining importance in multimodality imaging. It has become essential that clinicians and endosonographers thoroughly understand the peritoneal spaces and the ligaments and mesenteries that form their boundaries in order to localize disease to a particular peritoneal/subperitoneal space and formulate a differential diagnosis on the basis of that location. In this article we describe the applied EUS anatomy of peritoneal ligaments, infracolic and pelvic compartments of peritoneum and there technique of imaging from stomach, duodenum, sigmoid colon and rectum. Imaging from stomach images the infracolic compartment through transverse mesocolon, imaging from duodenum images the infracolic compartment through the mesentery and imaging from rectum and sigmoid images the infracolic and pelvic compartments through the sigmoid mesocolon and pelvic peritoneum.

Key words: Endoscopic ultrasound, infracolic compartment, infracolic space, pelvic compartment, pelvic space

INTRODUCTION

The peritoneal cavity is subdivided into supracolic and infracolic compartments by transverse mesocolon, which attaches the colon to the posterior abdominal wall.[1] The supracolic compartment contains the liver, spleen, stomach, and lesser omentum.[2-4] The infracolic compartment contains the coils of small bowel surrounded by the ascending, transverse, and descending colon [Figures 1 and 2].[3,4] The evaluation of different compartments of the peritoneum is gaining importance in multimodality imaging.[5-9] The applied EUS anatomy of the peritoneal ligaments has been described.[10] In this review, we describe the applied EUS anatomy of infracolic and pelvic compartments of the

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Figure 1. In this image, the transverse colon is visualized, anterior to the pancreas and duodenum. A collection is seen in the inferior recess of lesser sac bounded superiorly by the transverse mesocolon

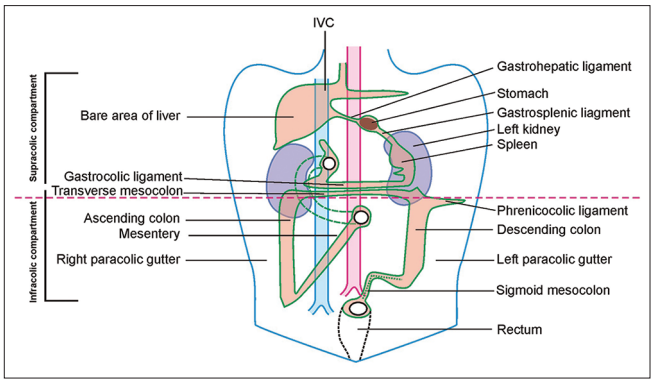

Figure 2. When the intestines are removed as far posteriorly as possible, the cut edges of the peritoneum are exposed as shown in the figure. The base of the transverse mesocolon lies horizontally across the duodenum and pancreas. To the right of the pancreas, this attachment line crosses the vertical segment of the duodenum and terminates at the hepatic flexure, whereas on the left, it terminates at the splenic flexure

peritoneum. Some of the images have been taken in patients of ascites to aid description of different compartments. Few images of radial EUS and computer tomography scan have been included, and the transverse mesocolon, mesentery (of the small bowel), and pelvic peritoneum are discussed.

The transverse mesocolon

The base of the transverse mesocolon lies horizontally across the duodenum and pancreas. To the right of the pancreas, this attachment line crosses the vertical segment of the duodenum and terminates at the hepatic flexure, whereas on the left, it terminates at the splenic flexure [Figure 2]. The upper limit of the infracolic compartment is the transverse colon, and the lower limit is in communication with the pelvis [Figure 1].

The spaces related to transverse mesocolon

The ascending, transverse, and descending colon enclose the central compartment. The right and left paracolic gutters are located lateral to the ascending and descending colon [Figure 3]. The right paracolic gutter is larger than left and both communicate with the pelvis. The right paracolic gutter communicates superiorly with the right intrahepatic space and thus connects the hepatorenal recess and rectovesical/rectouterine pouch of Douglas with each other in male and female, respectively [Figure 4]. The left paracolic gutter is separated from the left supracolic space by the phrenicocolic ligament, which is present near the lower pole of the spleen [Figure 3]. A similar kind of supporting ligament is not found near the hepatic flexure on the right side.

Imaging from stomach

Imaging of the infracolic compartment below the level of transverse mesocolon is possible through the posterior, inferior, and lateral wall of the stomach [Figure 5]. When imaging is done through the lateral wall of the stomach, the lower pole of the spleen and the inferior margin of the liver can be identified. In the presence of ascites, the paracolic gutters can be identified below the lower pole of the spleen and the inferior margin of the liver [Figure 6]. The hepatic and splenic flexures of the colon may be localized on the undersurface of the liver and spleen, respectively. In this position, limited evaluation of air-filled transverse colon is possible [Figures 7-9]. When the imaging beam is directed posteroinferiorly through the wall of the stomach, visualization of the small bowel loops of infracolic compartment is possible through the transverse mesocolon below the inferior border of the pancreas [Figure 10a and b].

Imaging from duodenum

Imaging of the transverse mesocolon and greater omentum is possible from the second and third parts of the duodenum [Figure 11]. The branches arising from the superior mesenteric artery (SMA), and the tributaries joining the superior mesenteric vein (SMV) can be located from this position. Identification of the mesenteric and antimesenteric borders of the vessels helps in further evaluation. The mesenteric border is identified by the presence of fan-shaped jejunal and ileal vessels. The transverse mesocolon is identified after following the middle colic artery, which is the second branch of the SMA arising from the antimesenteric border [Figures 12-15].

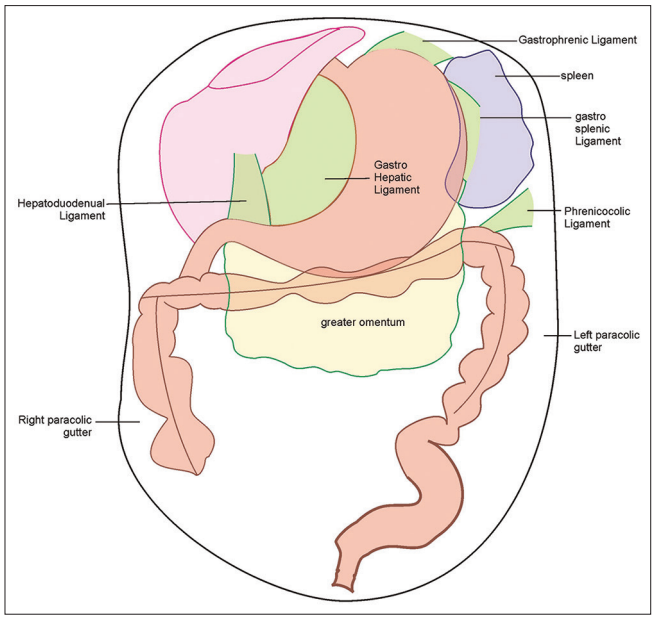

Figure 3. A section through the right end of the transverse colon shows the suprahepatic and subhepatic spaces on the right side. The paracolic gutters are seen on the side of the colon

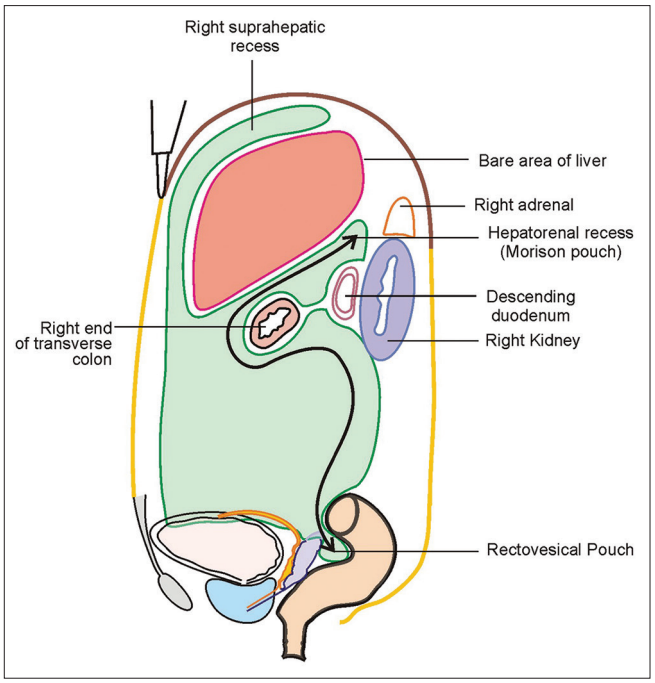

Figure 4. The hepatorenal space communicates with the pouch of Douglas. The tip of the arrows shows the most dependent parts

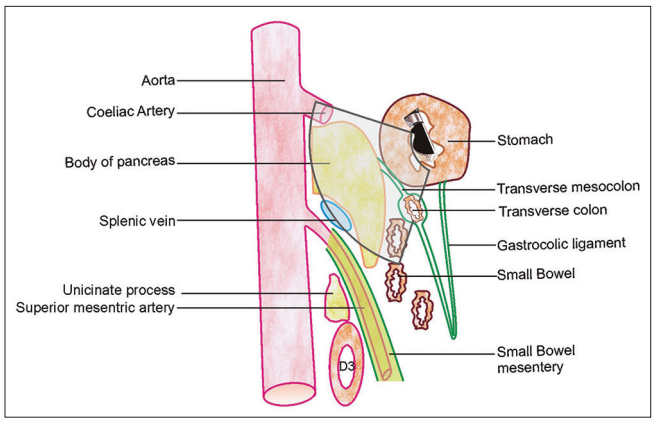

Figure 5. Imaging from the stomach shows the transverse mesocolon, through which the small bowel loops can be seen anterior to the mesentery

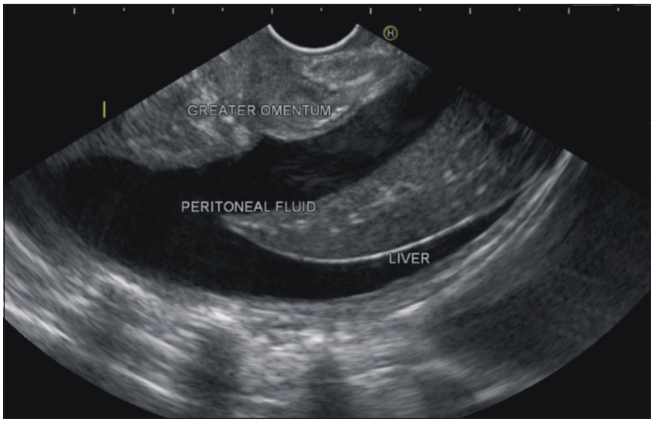

Figure 6. In this image, the greater omentum is thickened and lies near the wall of the stomach. The inferior surface of the liver is seen. The fluid below the inferior surface of the liver extends into the right paracolic gutter

The mesentery

The first 2 cm of the first part of the duodenum is intraperitoneal and lies in the supracolic compartment where it is surrounded by the lesser omentum above and the greater omentum below. The duodenum passes horizontally from the right to the left side of the infracolic compartment in front of the third lumbar vertebra and reaches the duodenojejunal flexure on the left side of the third lumbar vertebra [Figure 16]. The second part of duodenum passes behind the transverse mesocolon. The second part of the duodenum above the transverse mesocolon is related to supracolic compartment and the part below the second part of duodenum is related to infracolic compartment [Figure 16]. The mesentery and the mesenteric vessels are the most important home bases of imaging from the infracolic compartment. The mesentery is attached diagonally across the posterior wall of the infracolic compartment from the left side of L2 to the front of the right sacroiliac joint, extending from the duodenojejunal flexure to the ileocecal junction [Figure 16].

The spaces related to mesentery

The root of the mesentery acts as the divider of the infracolic compartment into right and left infracolic spaces, and generally, the imaging of SMA is possible at the point of origin from the third part of the duodenum [Figure 17]. The apex

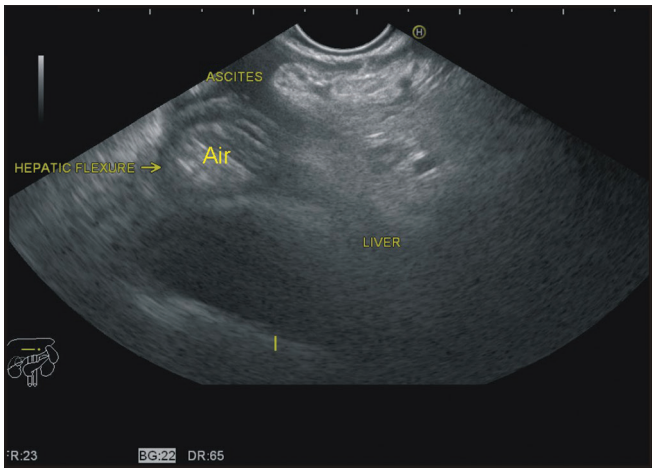

Figure 7. In this image, the hepatic flexure is seen adjacent to the liver making the upper right limit of the infracolic compartment

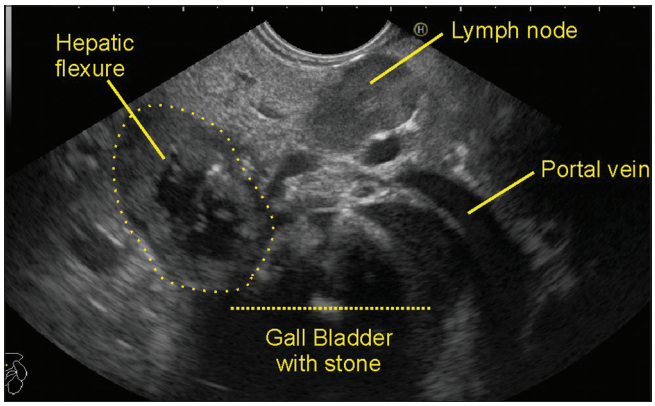

Figure 9. A case of carcinoma of the gallbladder with a stone. The hepatic flexure is seen below the gallbladder

of the triangular right infracolic space lies between the root of the mesentery, ascending colon, right two-third of the transverse colon, and transverse mesocolon. The base of the left infracolic space is directed downward and lies between root of the mesentery, descending colon, left one-third of the transverse colon, and transverse mesocolon. In the left iliac fossa, the infracolic compartment is limited inferiorly by the sigmoid colon and its mesentery, the sigmoid mesocolon [Figure 2]. The apex of the triangular right infracolic space lies at the ileocecal junction which separates it from the pelvic peritoneal spaces. It communicates with the left infracolic space toward the left side of attachment of root of the mesentery. The left infracolic space widens below and freely communicates with the pelvic peritoneal spaces through the pelvic inlet [Figure 2].

Imaging from stomach

Imaging of the infracolic compartment is possible from the stomach through the gastrocolic ligament, which

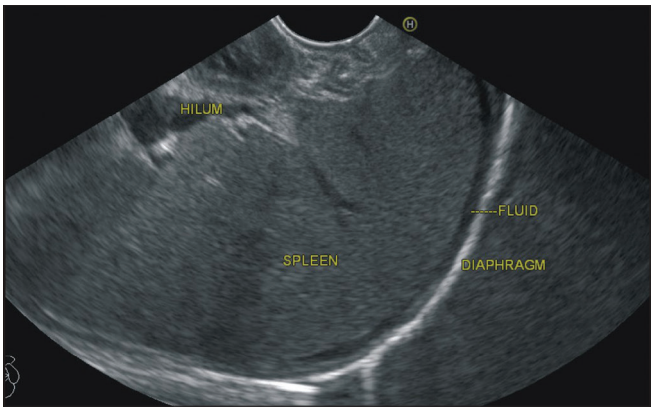

Figure 8. In this image, the splenic flexure is seen adjacent to the spleen making the left upper limit of the infracolic compartment

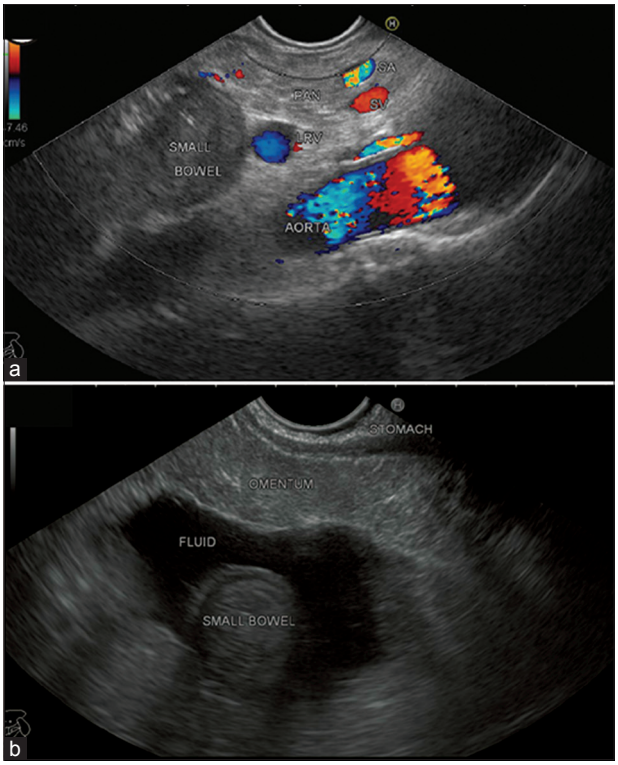

Figure 10. (a) In this image, the small bowel loop is seen along with the splenic vessels and aorta, which are seen in the left infracolic compartment. (b) In this case, the thickened greater omentum is seen, and the small bowel lying in the infracolic compartment is seen through the ascitic fluid. Fine-needle aspiration cytology of the omentum revealed malignancy metastatic deposit from the ovary

is identified on the greater curvature of the stomach. Gastrophrenic, gastrosplenic, and gastrocolic ligaments are attached to the greater curvature. During imaging from the stomach, when the diaphragm is seen, it shows the gastrophrenic ligament; when the spleen is seen, it shows the gastrosplenic ligament; and on continued rotation, when the lower border of the spleen is seen, it starts showing the gastrocolic ligament. The presence of parallel mesenteric vessels (SMA and SMV) which cross

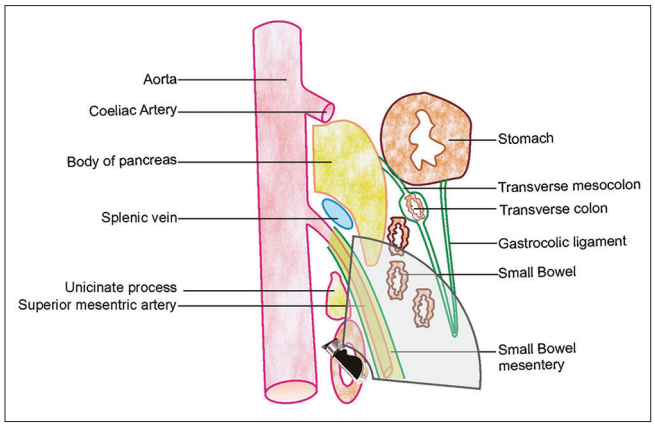

Figure 11. Imaging from the third part of the duodenum shows the small bowel mesentery, in which the SMA and SMV are seen. Through the mesentery, the small bowel loops can be seen. SMA: Superior mesenteric artery, SMV: Superior mesenteric vein

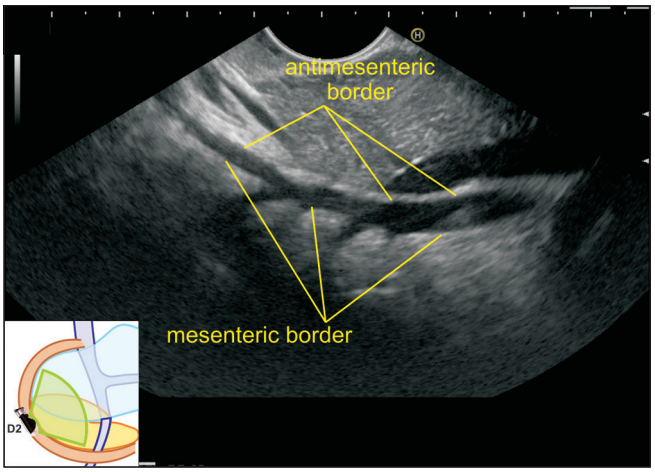

Figure 12. The mesentery containing the jejunum and ileum has a folded intestinal border about 40 times longer than its root (border – 6–7 m *vs.* root of the mesentery – 15 cm). In this image, the SMA is seen running parallel to the probe for a distance of about 7 cm. The mesenteric and the antimesenteric borders of the SMA can be identified. SMA: Superior mesenteric artery

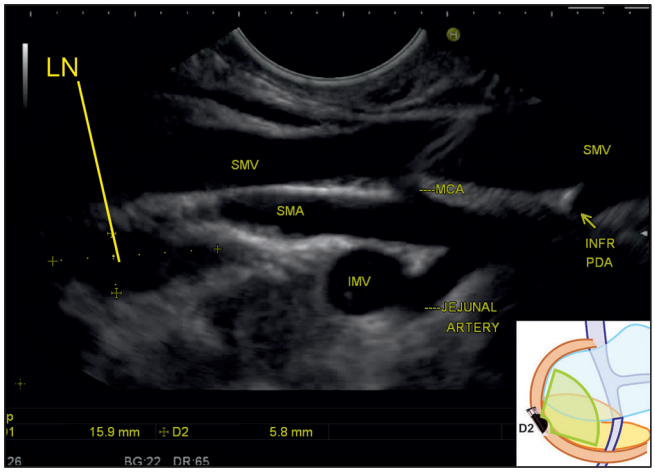

Figure 13. The middle colic artery is usually given off at the inferior margin of the neck of the pancreas before the SMA enters the mesentery. In this image, the second branch coming from the right side of the SMA is the middle colic artery, which is seen to enter the transverse mesocolon. MCA: Middle colic artery, INFR PDA: Inferior pancreaticoduodenal artery, IMV: Inferior mesenteric vein, SMA: Superior mesenteric artery

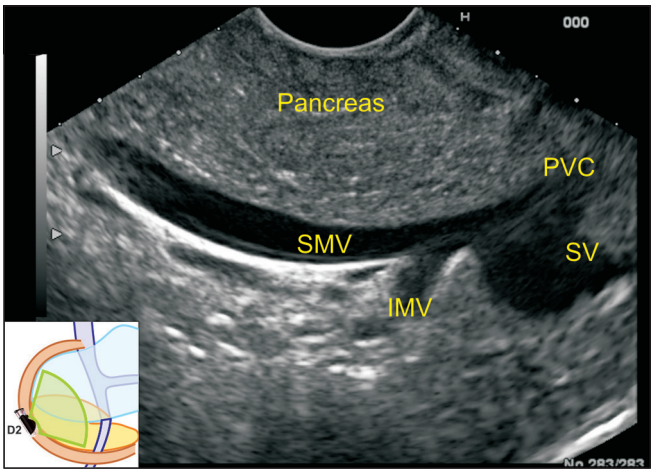

Figure 14. The SMV is seen for a distance of about 7 cm in this image and the tributaries joining the SMV can be identified. The border away from the probe is the left border of the SMV, and on that border, three tributaries are seen joining from below upward. The lowest is the first jejunal trunk, higher up is the IMV, and then the SV joins the SMV. SMV: Superior mesenteric vein, SV: Splenic vein, IMV: Inferior mesenteric vein

the uncinate process together and enter the mesentery is seen as the main home base [Figures 18 and 19a]. SMV can be followed down from the portal venous confluence [Figure 12]. A clockwise rotation from this position can trace the left infracolic compartment. The structures of the left infracolic compartment visualized during clockwise rotation are aorta and left kidney in front of the psoas major [Figure 19b-d]. On counterclockwise rotation, the inferior vena cava (IVC) and right kidney can be seen [Figures 20 and 21].

Imaging from duodenum

The numerous coils of the jejunum fill the upper part of the infracolic compartment, whereas the coils of the ileum fill the lower part of the infracolic compartment and pelvis [Figure 22]. The mesentery contains the blood vessels, lymphatics, and lymph nodes embedded in fat [Figures 23 and 24]. The root of the mesentery has right and left laminas. A clockwise rotation with the root of the mesentery and mesenteric vessels as a neutral home base will show the right peritoneal lamina and the right infracolic compartment and counterclockwise rotation will show the left peritoneal lamina and left infracolic compartment. The upper part of the right peritoneal lamina covers the pancreas and duodenum, and the lower part of the right peritoneal lamina covers the right ureter,

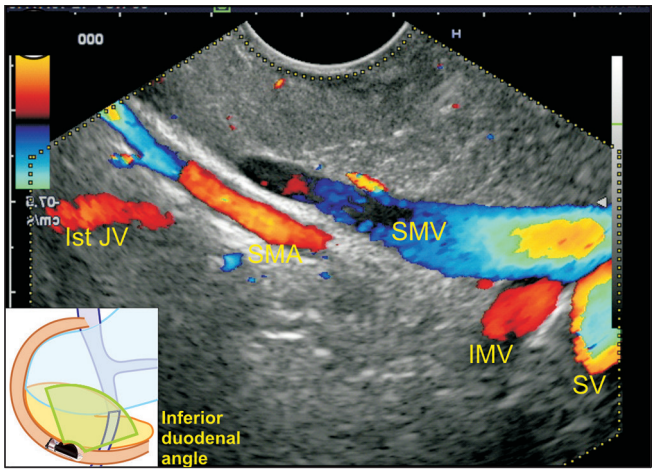

Figure 15. The first jejunal vein (first JV) is seen going toward the medial aspect of the superior mesenteric vein about 3 cm below the joining of IMV. SV: Splenic vein, SMV: Superior mesenteric vein, SMA: Superior mesenteric artery, IMV: Inferior mesenteric vein

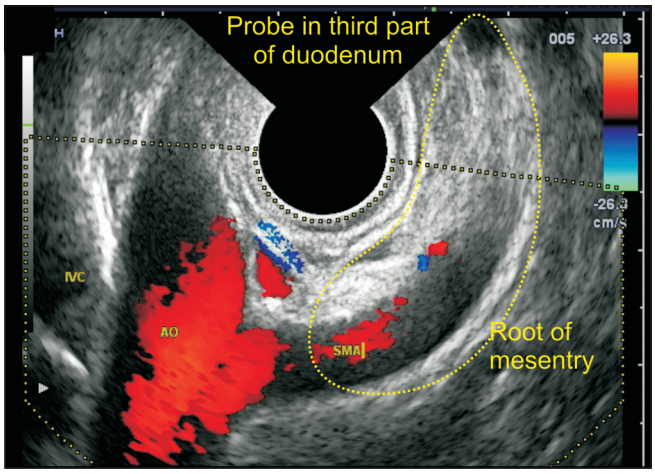

Figure 17. The root of the mesentery of the small bowel extends from the duodenojejunal flexure to the ileocecal junction, and at the beginning, crosses in front of the horizontal duodenum where it can be easily seen

the lower pole of the right kidney, and muscles of the posterior abdominal wall. Since the mesentery lies obliquely, the right lamina also covers the upper part of the IVC and aorta [Figure 2]. The left peritoneal lamina is continuous with the parietal peritoneum of an extensive quadrangular area that leads down into the pelvis. In this area, of the left infracolic compartment, retroperitoneal structures include the lower pole of the left kidney, the left ureter, the lower part of the IVC and the aorta, and both the left and right common iliac vessels [Figure 25]. The division into the right and left infracolic compartments help in factual understanding of the anatomical details.

The pelvic peritoneum and sigmoid mesocolon

The imaging of peritoneal cavity can be done from the middle and upper parts of the rectum and sigmoid

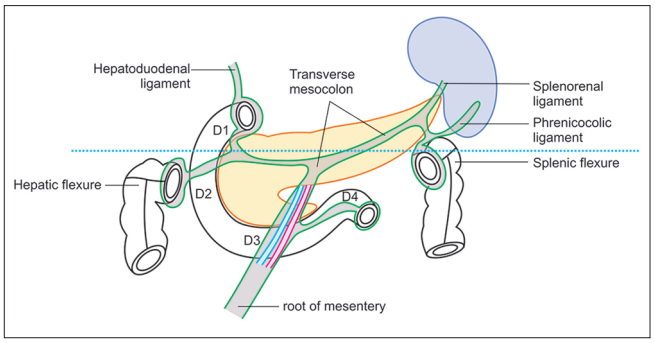

Figure 16. The blue line demarcates an approximate point below which the duodenum enters the infracolic compartment

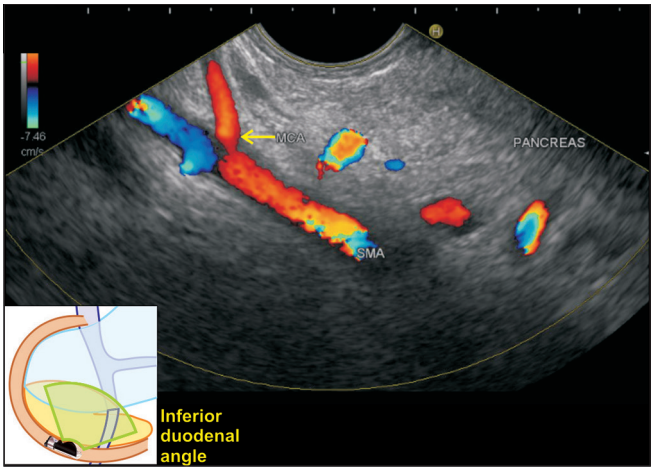

Figure 18. SMA is seen behind the pancreas taking origin from the aorta. In this case, the second branch of the superior mesenteric artery is seen going toward the transverse mesocolon below the pancreas. SMA: Superior mesenteric artery

colon. The peritoneal reflections near the rectum are different in males and females due to the presence of organs of reproduction. In males, the peritoneum covers the upper two-third of the anterior and upper one-third of the lateral surfaces of the rectum. The peritoneum sweeps forward from the rectum to the bladder and in this process dips slightly downward to the level of upper end of the seminal vesicles where it lies about 7.5 cm from the anal orifice [Figure 26]. In females, the peritoneum covers the upper two-third of the anterior and upper one-third of the lateral surfaces of the rectum, sweeps forward from the rectum, covers the posterior fornix of the vagina, and then passes onto the back of the cervix and body of the uterus, forming the rectouterine fold. This fold dips downward to form the rectouterine pouch (of Douglas), the bottom of which is about 5.5 cm from the anal orifice. It invests completely the posterior and anterior surfaces of the uterus before reflecting onto the superior surface of the bladder forming the uterovesical pouch [Figure 27]. Anteriorly,

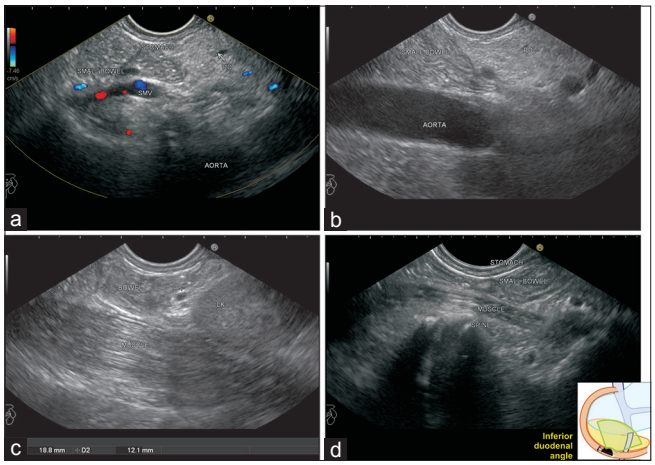

Figure 19. (a) The SMV runs behind the body of the pancreas. It can be followed below the pancreas and its tributaries can be sometimes seen. In this case, the bowel loops are seen between the wall of the stomach (to which the gastrocolic ligament is attached) and the superior mesenteric vein, which lies within the mesentery. (b) On further rotation from the previous position, the aorta is seen. The small bowel loops are seen between the aorta and stomach. (c) On further rotation from the previous position, the left kidney is seen. The small bowel loops are seen lying anterior to the psoas major below the lower pole of the left kidney. (d) On further rotation from the previous position, the spine is seen. The small bowel loops are seen between the spine and stomach. SMV: Superior mesenteric vein

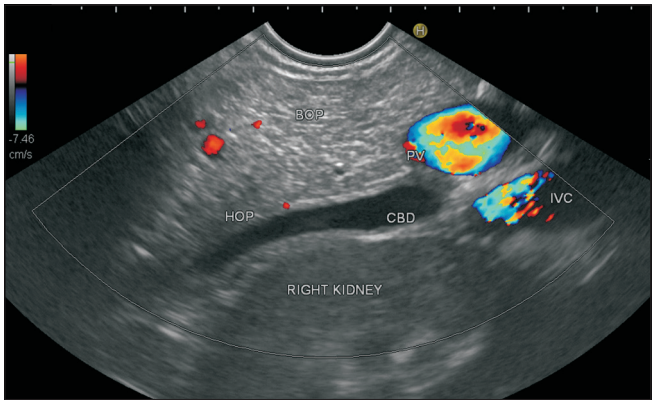

Figure 21. On counterclockwise rotation after visualizing the portal venous confluence, the common bile duct is seen. In this image, the IVC and the right kidney are seen. IVC: Inferior vena cava

the peritoneum ascends from the superior surface of the bladder toward the umbilicus in both sexes where it is folded up into the median, medial, and lateral umbilical folds. Laterally, the peritoneum of the rectum (and the bladder) continues with the parietal peritoneum of the pelvic wall. The sigmoid colon lies in front of the sacrum. The sigmoid mesocolon is an inverted V-shaped mesentery that attaches the sigmoid colon to the posterior pelvic wall along the line of an inverted V [Figure 2]. The left limb of the V is in the left iliac fossa and the right limb descends into the pelvis. The apex of the right limb is located in front of the left ureter and division of the left common

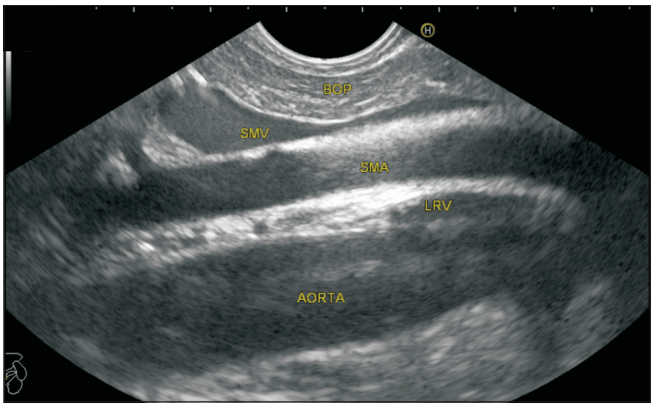

Figure 20. On clockwise rotation after visualizing the portal venous confluence, the aorta is visualized along with the left renal vein and superior mesentery vessels behind the body of the pancreas

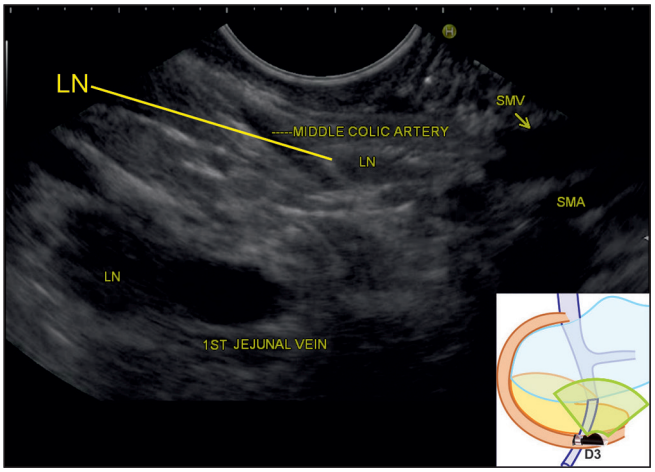

Figure 22. In this image, the first jejunal vein which is a tributary of the mesenteric vein is identified on counterclockwise rotation after identifying the SMV going toward the bowels in the infracolic compartment. A lymph node is seen along the middle colic artery and first jejunal vein. SMV: Superior mesenteric vein

iliac artery [Figures 2 and 28]. Imaging of the iliac vessels is a key point of rectosigmoid imaging, and it is usually possible to see the bifurcation of the aorta and the union of iliac vessels to form the IVC from the sigmoid colon [Figures 29-33]. Laterally, the peritoneum of the rectum/sigmoid colon comes within 1 to 2 cm distance of the iliac vessels which run close to the ischial spine and are easily seen with the application of color Doppler against the bony shadow of the ischium. In the presence of ascites, the ischial spine creates an indentation on the rectovesical/rectouterine pouch and gives an hourglass appearance in the presence of ascites.

The spaces related to pelvic peritoneum and sigmoid mesocolon

The pelvic spaces are in free communication with the paracolic gutter and infracolic compartments. In women,

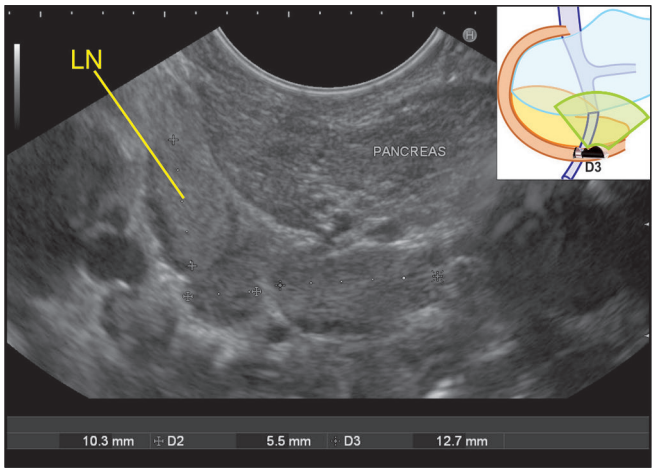

Figure 23. In this case, the lymph node is seen within the small bowel mesentery, which is identified below the pancreas. This lymph node is still in a subperitoneal compartment/not in a peritoneal compartment

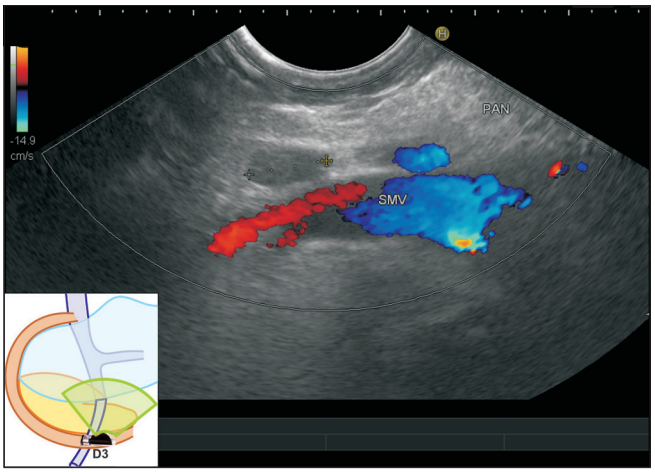

Figure 24. In this case, a lymph node is seen near the lower border of the pancreas from the horizontal part of the duodenum anterior to the superior mesenteric vein just below the place where it crosses the uncinate process. This lies within the small bowel mesentery

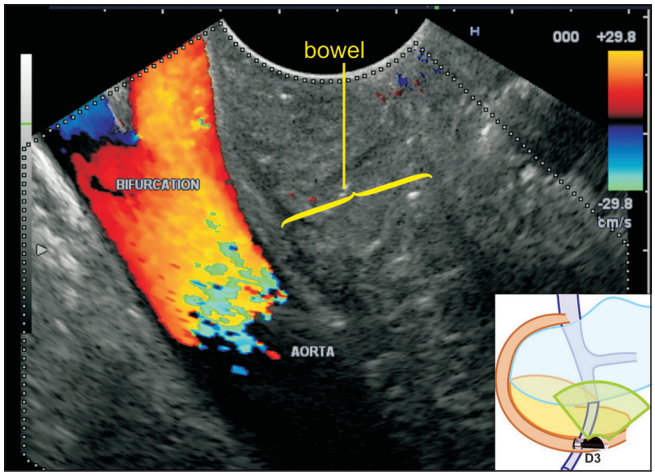

Figure 25. An counterclockwise rotation from the baseline position of the mesenteric vessels traces the aorta and IVC. A part of the aorta lies in the right and part lies in the left infracolic compartments. In this case, the bifurcation of the aorta is seen during imaging from the duodenum, and small bowel loops are seen between the third part of the duodenum and bifurcation of the aorta, which lies in the left infracolic compartment. IVC: Inferior vena cava

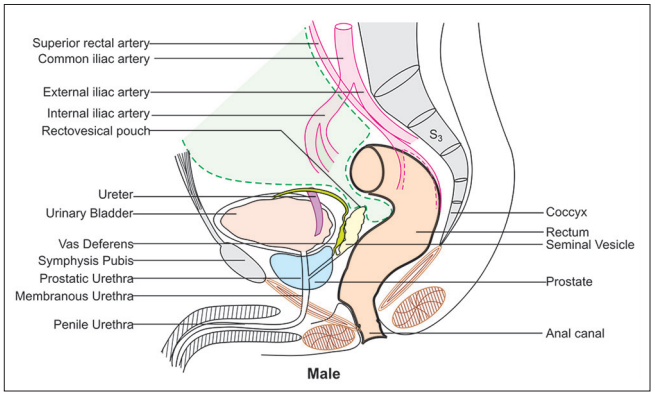

Figure 26. While going from the rectum to the bladder in male and from the rectum to the uterus in female, the peritoneum comes to the most inferior location in the pelvis and touches the seminal vesicle or posterior fornix (uterocervical angle) of the vagina

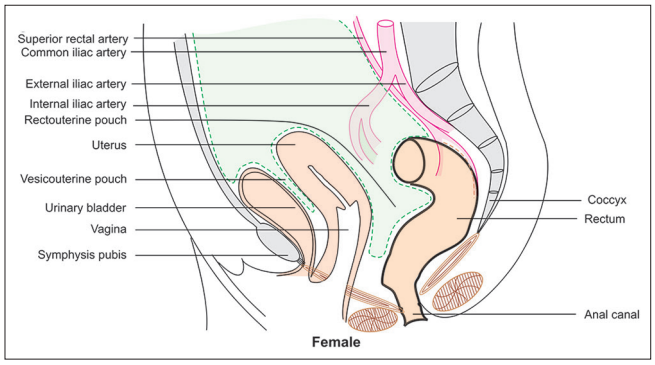

Figure 27. The peritoneal reflection is superior to the bladder in the male and above the uterus and bladder in the female

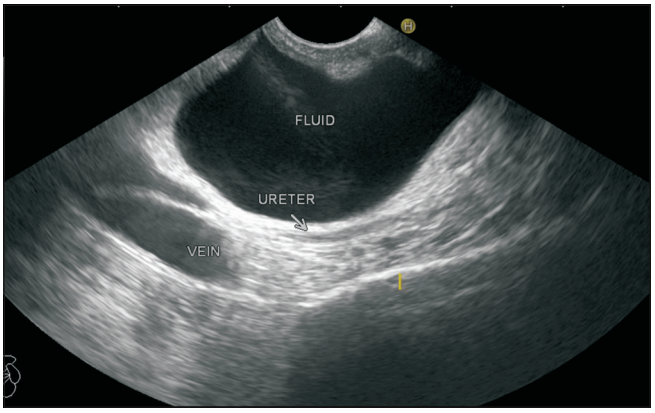

Figure 28. In this EUS image from the rectosigmoid junction, the common iliac vessels are seen along with the left ureter

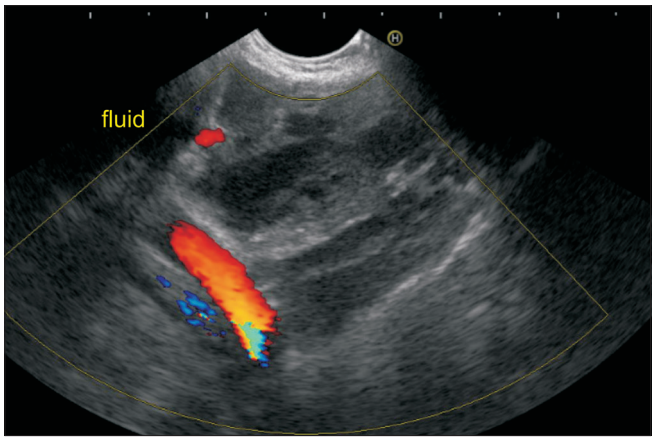

Figure 29. In this case, ascites is seen above the rectum. The union of the iliac vein is seen through the fluid-filled peritoneal cavity

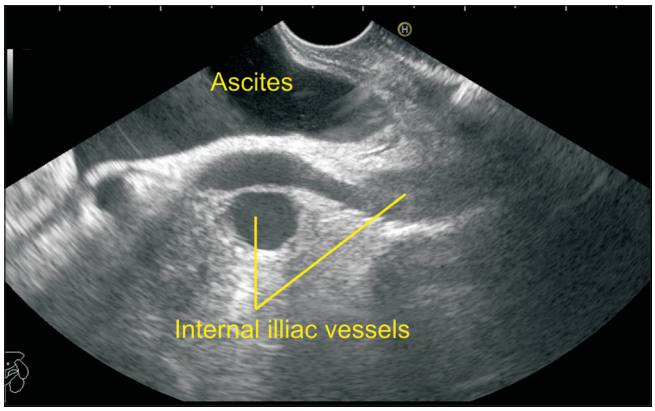

Figure 31. Imaging of EUS from the proximal rectum of the lateral pelvis showing the pararectal space which contains fluid. The common iliac vessels are visualized running into the pararectal space

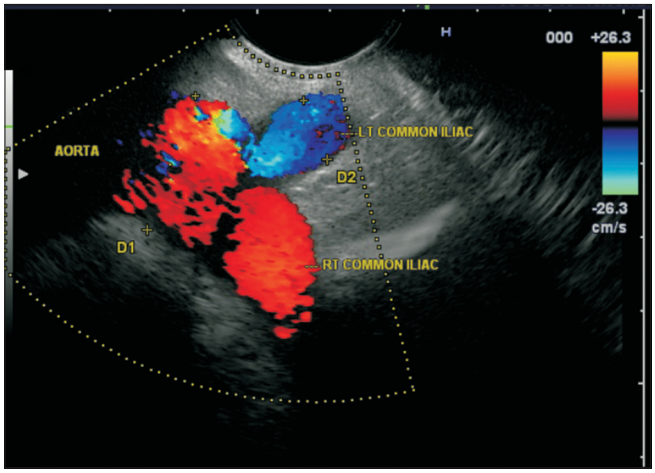

Figure 33. Imaging of the lowest part of the descending aorta is possible from the rectum. The scope should be positioned at about 20 cm distance (~rectosigmoid). From the rectosigmoid junction, the vessel coming toward the probe is the left common iliac artery

the space between the rectum and uterus is defined as the rectouterine space (the pouch of Douglas) and the space between the uterus and bladder is called as

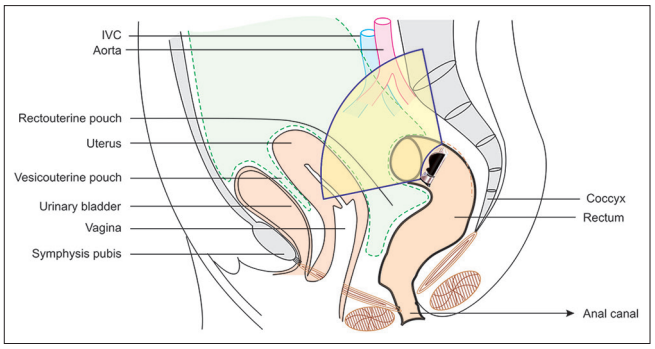

Figure 30. The line art image shows the direction of the beam during imaging from the upper rectum in females

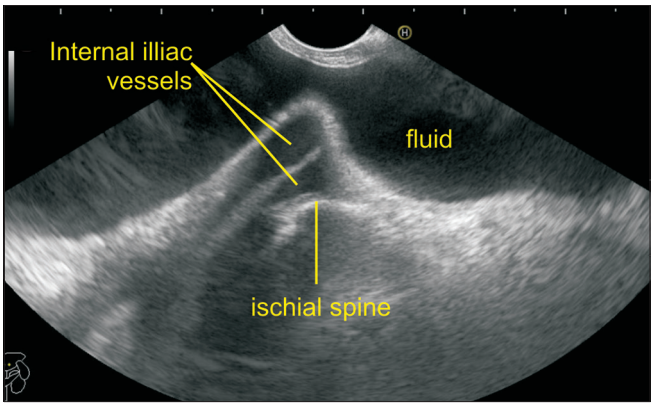

Figure 32. Imaging of EUS from the proximal rectum of the lateral pelvis showing hourglass appearance of the pararectal space containing fluid. The common iliac vessels are visualized running into the lateral pararectal space

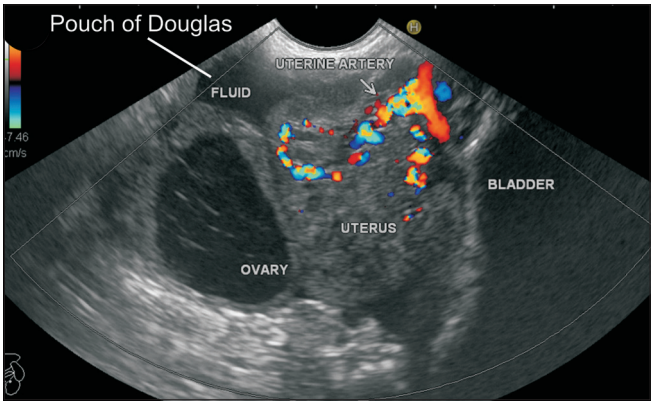

Figure 34. In this image, the pouch of Douglas is seen between the anterior wall of the rectum and the uterus

the uterovesical pouch [Figures 34-36]. In male, the rectovesical space is present between the bladder and rectum [Figure 37].

Imaging of spaces related to pelvic peritoneum and sigmoid mesocolon

The imaging of the pelvic spaces is possible through the anterior and lateral wall of the rectum and from the sigmoid colon by identifying the home base stations.

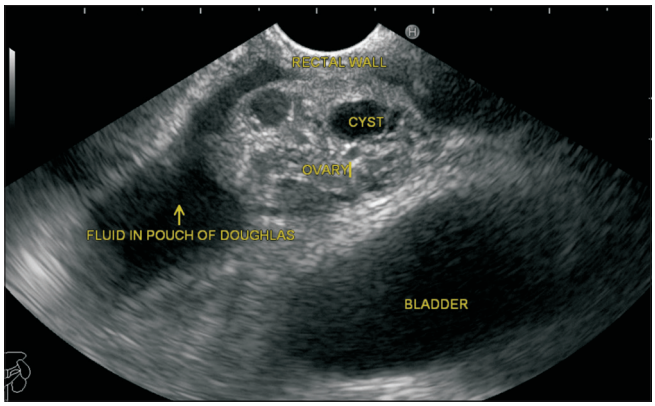

Figure 35. The bladder is seen beyond the pouch of Douglas, which is filled with fluid in a case of ovarian cyst

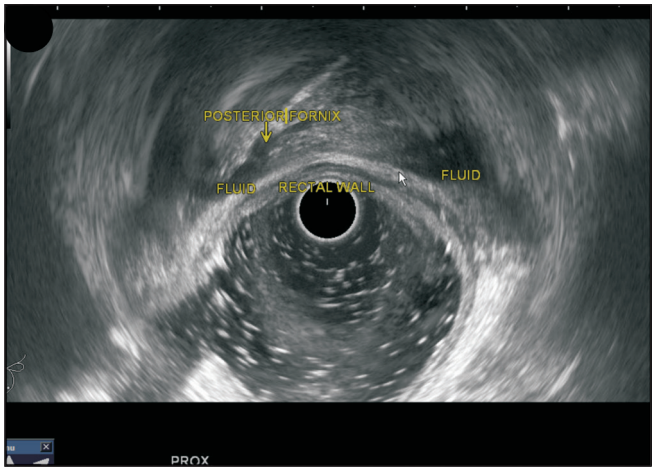

Figure 36. In this radial EUS image, from the rectum, the posterior fornix of the vagina is seen lateral to the cervix. There is the presence of fluid anterior to the rectal wall in the pouch of Douglas which forms the lowest limit of the peritoneal cavity

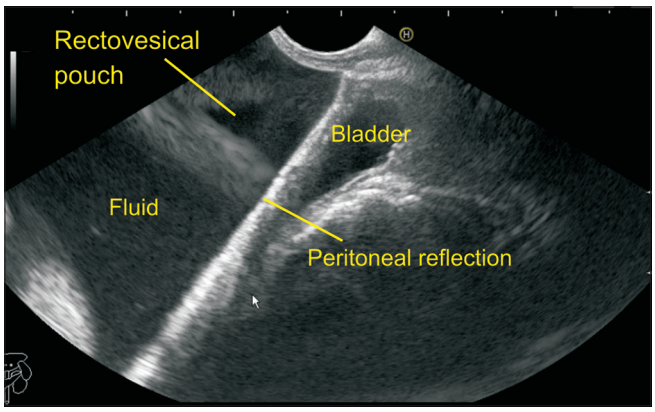

Figure 37. EUS in a male patient with ascites shows a reflection of the peritoneum from anterior surface of the rectum to superior surface of the bladder forming a rectovesical pouch

The presence of the prostate helps in defining the upper boundary of the lower one-third of the anterior wall of the rectum and the upper limit of the seminal vesicle locates the lower limit of the rectovesical space in males [Figure 37]. In females, the anterior wall of the upper rectum shows the uterus and distended bladder [Figures 34-36]. The lateral wall shows the division of the iliac vessels and the ureter. The lower limb of the sigmoid mesentery is identified due to its close proximity with the ileal vessels and the ureter. It is easy to identify the large caliber retroperitoneal vessels through the sigmoid mesentery from the upper rectum and rectosigmoid junction. During imaging from the upper rectum and sigmoid, the left infracolic compartment, the retroperitoneal structures (lower part of the IVC and the aorta and both left and right common iliac vessels), and the bowel loops can be seen [Figure 25].

DISCUSSION

The imaging of the infracolic compartment and pelvis is possible by EUS from the stomach, duodenum, and rectum. Imaging from stomach images the infracolic compartment through the transverse mesocolon, imaging from the duodenum images the infracolic compartment through the mesentery, and imaging from the rectum and sigmoid images the infracolic and pelvic compartments through the sigmoid mesocolon and pelvic peritoneum. It has become essential that clinicians and endosonographers thoroughly understand the peritoneal spaces and the ligaments and mesenteries that form their boundaries to localize disease to a particular peritoneal/subperitoneal space and formulate a differential diagnosis on the basis of that location. In this article, we have described the normal EUS anatomy of the infracolic compartment of the peritoneum. This information may be useful to understand the spread of disease processes and in sampling of fluids, lymph nodes, or deposits in different compartments of the peritoneum.

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Conflicts of interest
There are no conflicts of interest.

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