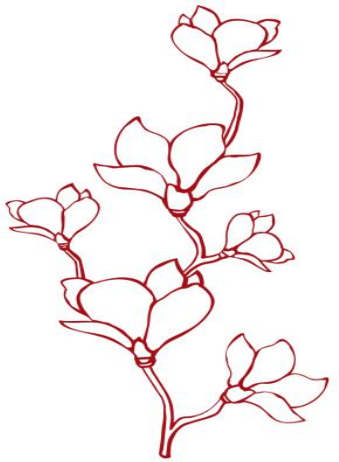
Radiological findings of ischemic abdominal diseases.

Seong Jin Park, Hyun Cheol Kim, Ji Seon Park, Myung-Won You, Sung Kyoung Moon,

Department of Radiology

Kyung Hee University Hospital, Seoul, Korea



Introduction

- Ischemic abdominal diseases are major causes of GI symptoms including serious abdominal pain, hematochezia, nausea/vomiting, etc. Relatively these diseases have high morbidity and mortality. Therefore early detection and immediate management are very important in daily practice. Ischemic abdominal diseases are commonly caused by inadequate blood flow to the abdominal organs.

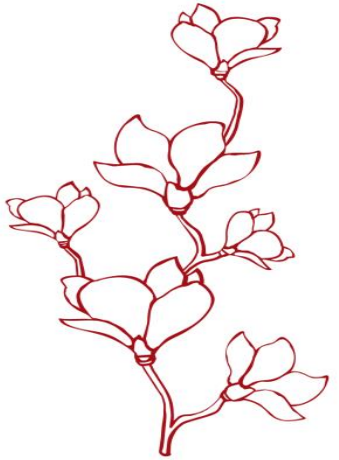
Introduction

- Majority of these entities are composed by ischemic bowel diseases, omental/mesenteric infarction, omental/mesenteric infarction, and epiploic appendagitis, ischemia/infarction of the solid abdominal organs, spleen, and kidneys. Intestinal obstruction including trauma, closed loop obstruction, volvulus, internal hernia can be associated with ischemia. In early infant, midgut volvulus is common cause of ischemic bowel disease. This exhibit will illustrate characteristic ultrasonographic(US) findings of these disease entities, compared with computed tomography(CT).

Splenic infarction

Splenic infarction is a condition in which oxygen supply to the spleen is interrupted, leading to partial or complete infarction (tissue death due to oxygen shortage) in the organ. The classic US appearance of an acute splenic infarct is a peripheral wedge-shaped hypoechoic lesion showing diminished flow on color Doppler imaging(CDI). The “bright band sign” can be useful to diagnose splenic infarction by US, than results from specular reflections returned from fibrous trabeculae that remain intact within infarcted parenchyma. CT scan is the most commonly used modality to confirm the diagnosis.

Infarction of Solid Organs



Splenic torsion

Wandering spleen is an uncommon clinical entity that results from abnormal laxity or absence of the supporting ligaments. On gray scale US the spleen is absent from its position in the left upper abdomen and instead a capsulated mass is visualized in the abdomen or pelvis. It shows a heterogeneous, and predominantly hypoechoic echotexture with reduced or absent intraparenchymal and/ or splenic hilar flow on CDI. On non-contrast CT the spleen shows lower density values than the hepatic parenchyma. The spleen may also be enlarged with minimal or no post-contrast enhancement of the parenchyma suggesting infarction.

Splenic infarction

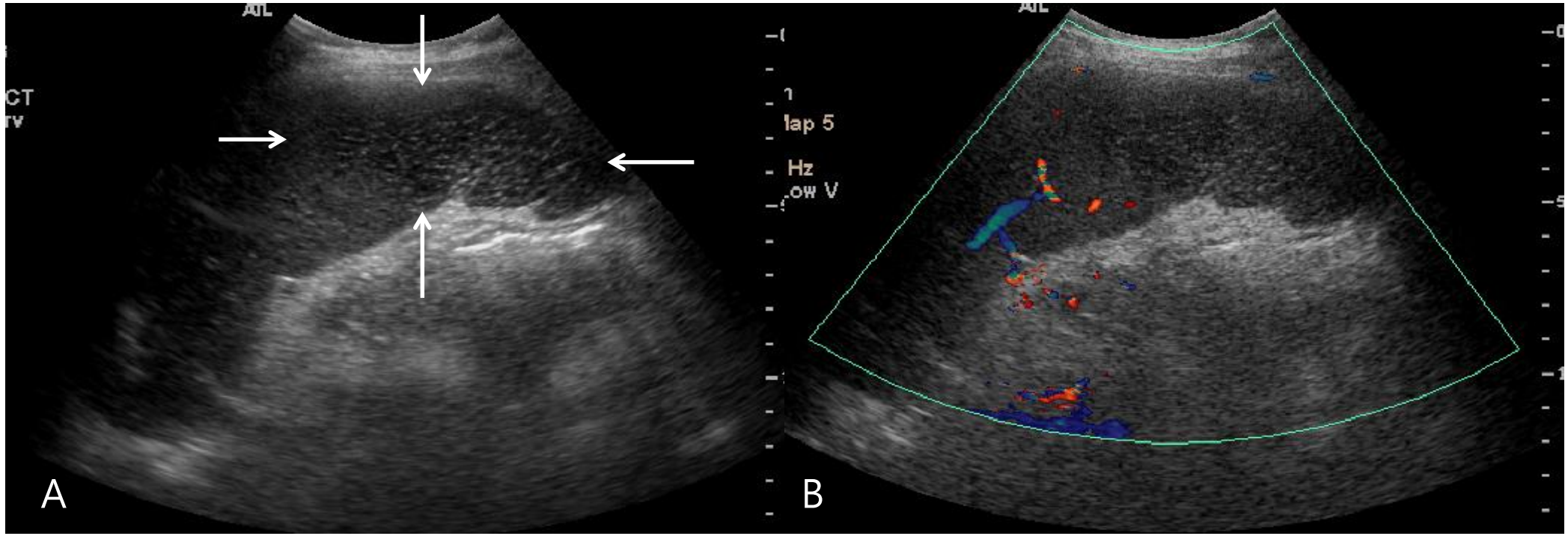


Figure 1. A 45-years-old female with focal splenic infarction after surgery. A. Gray-scale US shows "bright band sign" within wedge-shaped hypoechoic area(arrows). B. CDI shows no flow signal in the infarcted parenchyma.

Splenic torsion

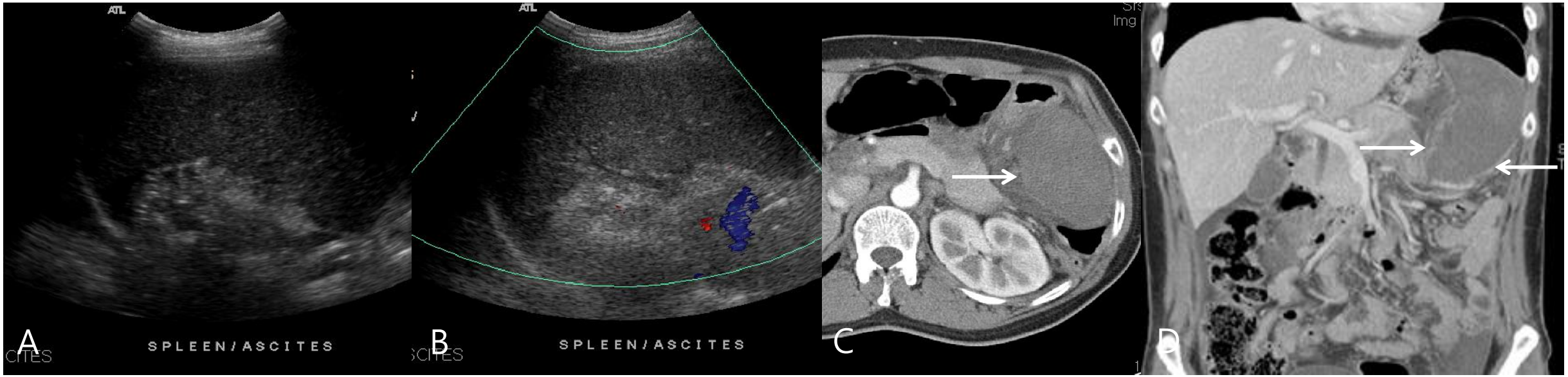


Figure 2. A 31-years-old female with splenic torsion. A. Gray scale US shows hypoechoic splenic parenchyma with enlargement. B. CDI shows absence of flow within the spleen. Axial(C) and Coronal images(D) of enhanced CT shows a infarcted spleen without enhancement, locates lower than normal position(arrow).

Gallbladder torsion

- Torsion of the gallbladder is an extremely rare cause of acute abdomen. It is defined as a rotation of the gallbladder on the mesentery along the axis of the cystic duct and artery. Clinically, symptoms of gallbladder torsion are similar to those of acute cholecystitis make it difficult to diagnose preoperatively.
- Torsion of the gallbladder is believed to occur in anatomically predisposed patients, congenital floating gallbladder. Abdominal US showed an enlarged gallbladder, a thickened wall and a small amount of ascites between the gallbladder and liver. CDI showed no intramural blood flow in the wall of the gallbladder.
- CT features suggesting gallbladder torsion are horizontal misplacement, presence of a well-enhanced cystic duct located on the right side of the gallbladder, and a liver bed indicating a ‘floating gallbladder’. A rare, but very specific sign on CT is the so-called ‘whirl sign’. This sign is only visible if the plane of CT is perpendicular to the axis of the twisted gallbladder mesentery.

Gallbladder torsion

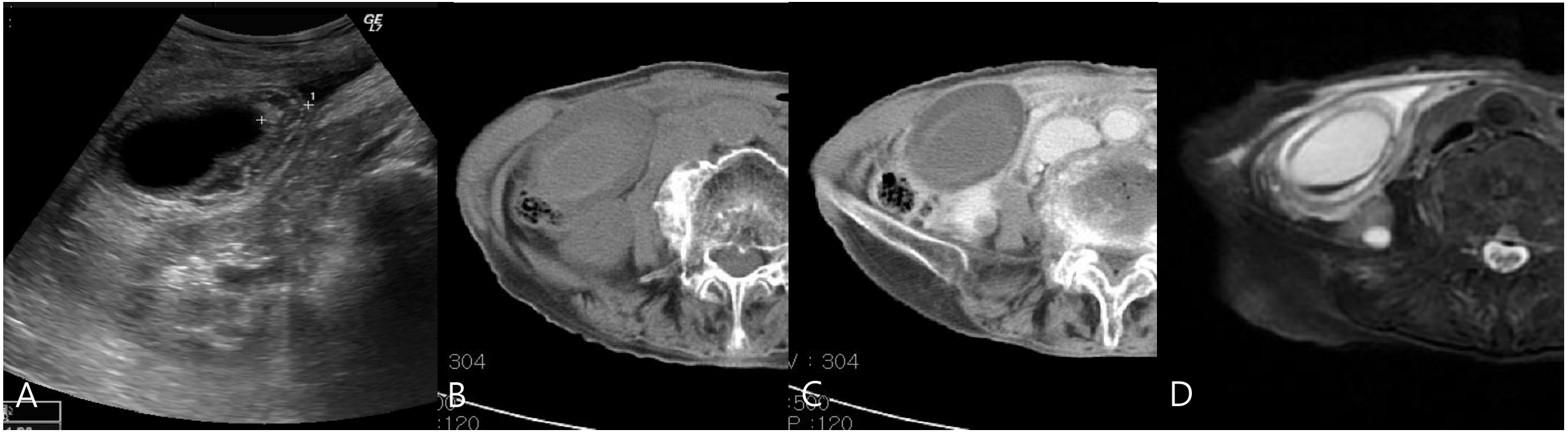


Figure 3. A 80-years-old female with gallbladder torsion. A. Gray scale US shows marked wall thickening and distention of the gallbladder with pericholecystic fluid collection. B. Non-contrast CT scan shows marked wall thickening with high-attenuation content in the gallbladder lumen, and horizontal midplacement. C. Contrast enhanced CT scan shows no wall enhancement. D. T2WI MR imaging shows wall thicknening composed by submucosal edema and blood content in the GB lumen and pericholecystic fluid collection. During operation, the gallbladder was torsed. This case does not show whirl sign, so it is hard to distinguish from acute cholecystitis.

Hepatic infarction

- Hepatic infarction is uncommon because of the dual blood supply from the hepatic artery and portal vein, as well as extensive collateral vessels. In most cases, hepatic infarction results from either insult to the hepatic artery and portal vein occlusion. Hepatic infarction may be iatrogenic, occurring after hepatobiliary surgery, intrahepatic chemoembolization, or a transjugular intrahepatic portosystemic shunt procedure. On CT scan, wedge-shaped areas are predominantly peripheral and extend to the capsular surface, whereas rounded areas tend to be central in location.
- Gas formation has been described in sterile infarcts as well as infected ones. Sterile gas is related to the release of intracellular gas from necrotic tissue. Non-enhancing parenchyma manifest as perfusion defects and typically are distributed in a geographic or segmental pattern with or without straight margins. Doppler ultrasonography should be performed to assess the patency of the hepatic artery.

Hepatic infarction

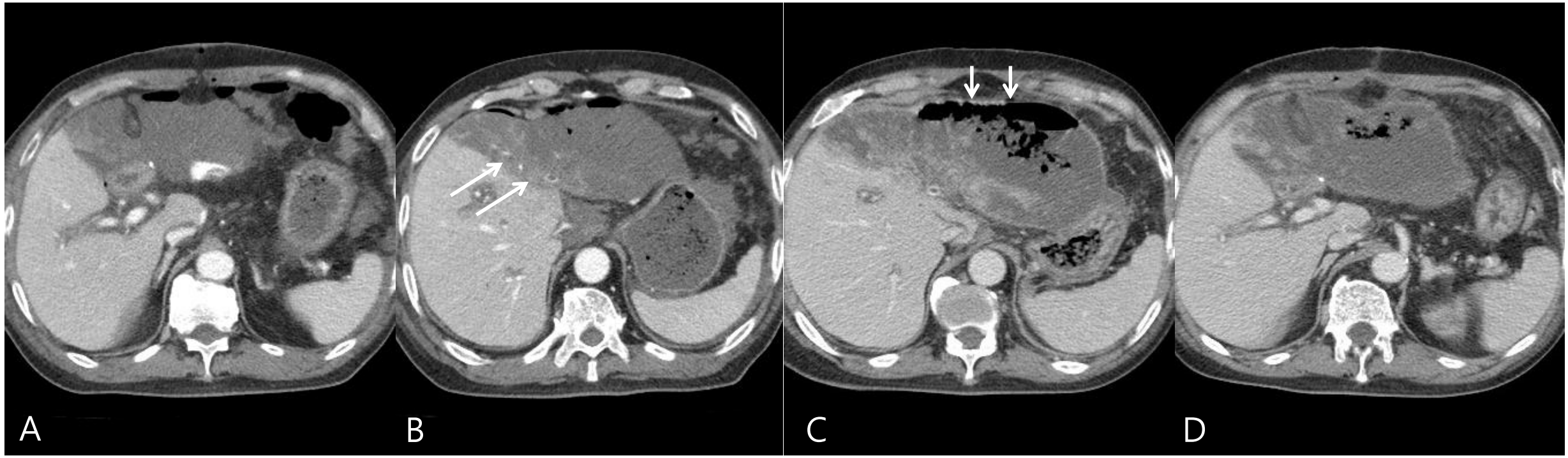
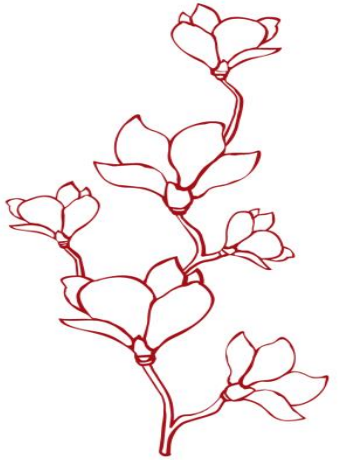


Figure 4. A 74-days-old male with hepatic infarction, who underwent segmental resection of extrahepatic duct for cholangiocarcinoma A-B. CT scan obtained on 2days after surgery shows poor parenchymal enhancement of the left hepatic lobe with sharp demarcation(arrows). Air collection and contrast leakage within the infarcted left hepatic lobe are also noted. C-D. CT scan obtained on 7days after surgery shows increased amount of air bubbles(arrows) within the infarcted left hepatic lobe. US(not shown) reveals air bubbles in the infarcted left hepatic lobe, that interferes visualization of the liver parenchyma.

Epiploic Appendagitis and Omental Infarction



Epiploic appendagitis(EA)

Torsion of epiploic appendages, with resultant vascular occlusion or venous occlusion that leads to ischemia, has been implicated as the cause of acute EA. The characteristics of acute EA on US images, as described in the literature, are an oval noncompressible hyperechoic mass at the site of maximum tenderness, adjacent to the colon, with no central blood flow depicted on CDI. The most common CT feature in acute EA is an oval lesion less than 5 cm in diameter, that abuts the anterior colonic wall, and that is surrounded by inflammatory changes.

Epiploic appendagitis(EA)

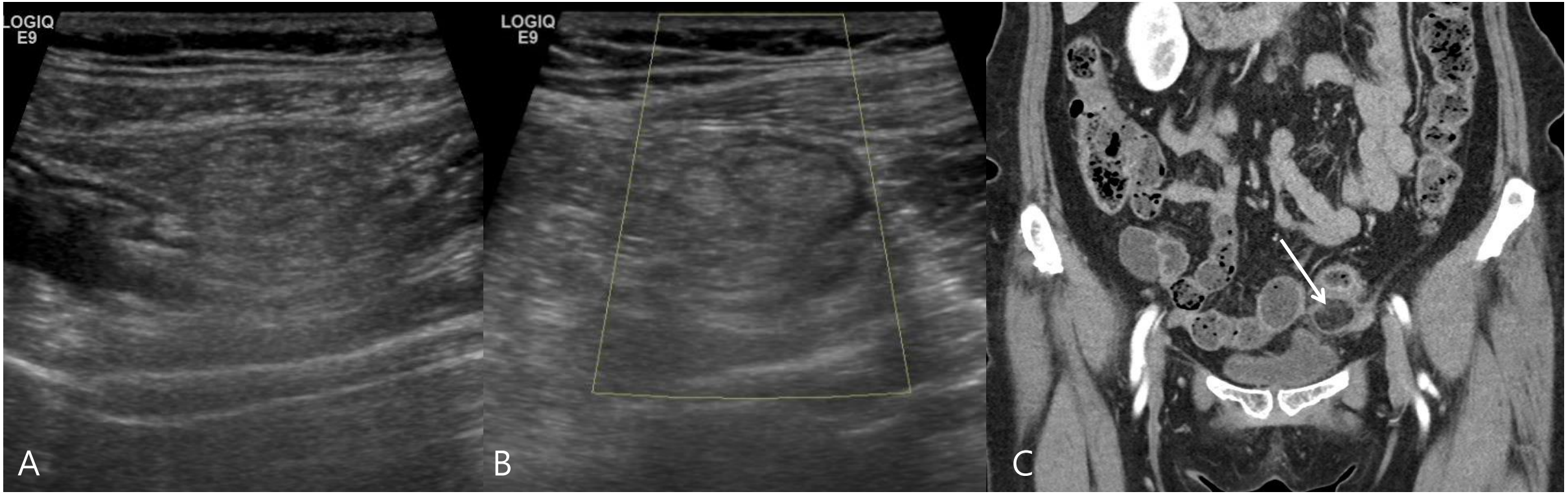


Figure 5. A 58-years-old female with epiploic appendagitis. A-B. Transverse US on lower abdomen shows a oval hyperechoic nodule surrounded by thin low echoic rim, adjacent to the sigmoid colon without internal vascularity on CDI. C. Coronal view of enhanced CT shows a well-demarcated fatty mass(arrow) adjacent to the sigmoid colon, that is surrounded by inflammatory changes.

Omental infarction

Pathologic findings of omental infarction include congestion, hemorrhage, fat necrosis, and inflammatory cell infiltration. In most patients segmental omental infarction is a self-limited. Omental infarction is typically triangular and involves the inferior aspect of the right side of the omentum. It is characteristically situated between the anterior abdominal wall and the transverse or ascending colon. Both CT and sonography show an ovoid or cakelike soft-tissue mass. The infarcted omental fat is hyperechoic on sonography and shows mixed attenuation on CT.

Epiploic appendagitis(EA)

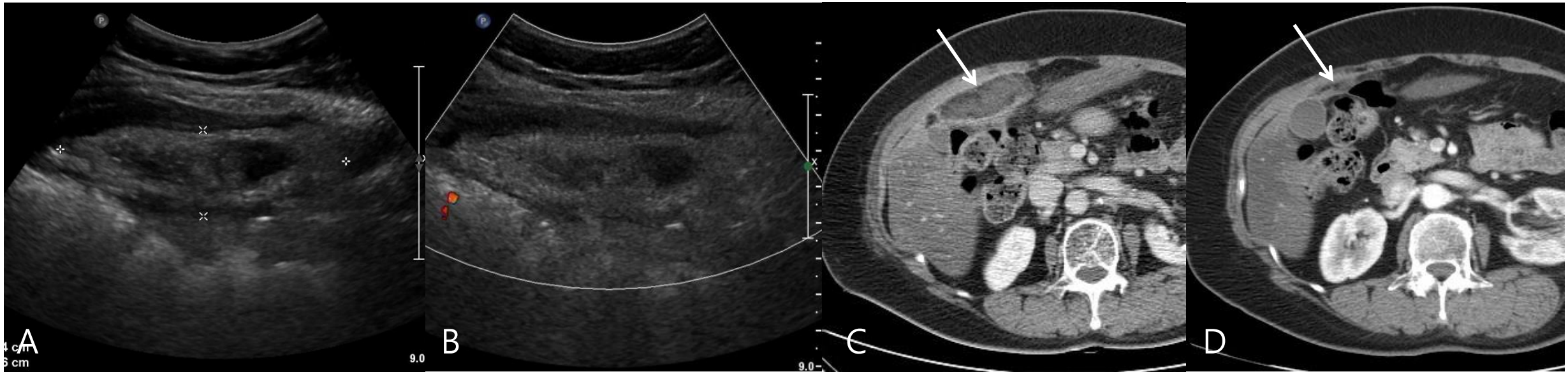
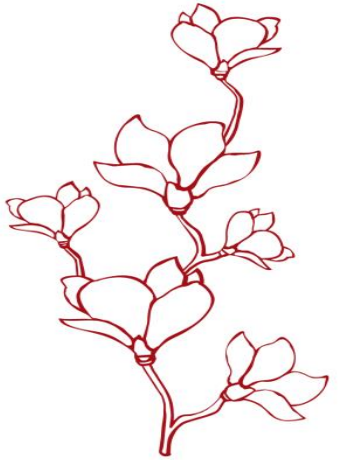


Figure 6. A 58-years-old female with omental infarction. A-B. Transverse US on right upper abdomen shows a cakelike hyperechoic mass with central hypoechoic area without internal vascularity on CDI. C. CT shows a cakelike fatty mass with central soft tissue attenuation(arrow), indicating fat necrosis or internal hemorrhage. D. Follow-up CT after 45 days shows shrunken fatty mass(arrow), that prove omental infarction is self-limited disease.

Ischemic Disease of the Intestines



Mid-gut Volvulus

Midgut volvulus is a life-threatening emergency in children. In case of bowel malrotation, shortened mesenteric pedicle predispose to midgut volvulus. In malrotation, the SMV may appear anterior, or more definitively, to the left of the SMA. The “whirlpool” sign refers to the sonographic appearance of the SMV wrapping around the axis of the SMA in volvulus when using color Doppler sonography.

Midgut Volvulus

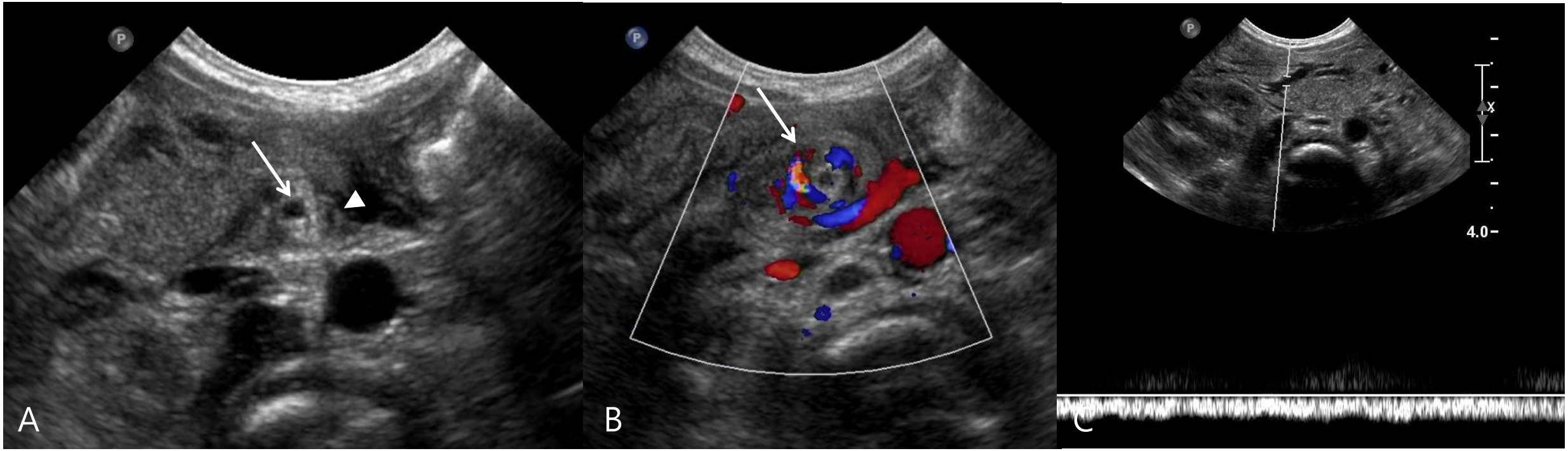
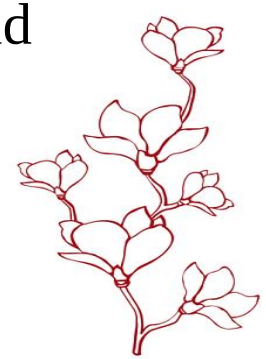


Figure 7. A 2-days-old boy with midgut volvulus. A. Transverse midline abdominal US with a high-frequency transducer shows SMA (arrow) to the right of the SMV(arrowhead). B. CDI shows "whirlpool sign" that SMV and mesenteric fat wrapping around the SMA(arrow). C. Gray-scale US shows engorged mesenteric veins.

Ischemic bowel disease

Intestinal ischemia is an abdominal emergency that accounts for approximately 2% of gastrointestinal illnesses. It represents a complex of diseases caused by impaired blood perfusion to the small and/or large bowel including acute arterial mesenteric ischemia (AAMI), acute venous mesenteric ischemia (AVMI), non occlusive mesenteric ischemia (NOMI), ischemia/reperfusion injury (I/R), ischemic colitis (IC). CT and US are the most commonly used imaging modalities in patients with acute abdomen, and even if CT represents the gold standard in the evaluation of patients with ischemic bowel disease.



Ischemic bowel disease

- **Acute arterial mesenteric ischemia**
  - CDI can show stenosis, emboli, and thrombosis in the near visible parts of the celiac trunk, the SMA and the IMA.
- **Acute venous mesenteric ischemia**
  - US may reveal thrombus at the SMV origin and mural thickening with hyperechoic mucosal layers and hypoechoic submucosa attributable to edema of the affected bowel.

Acute arterial mesenteric ischemia

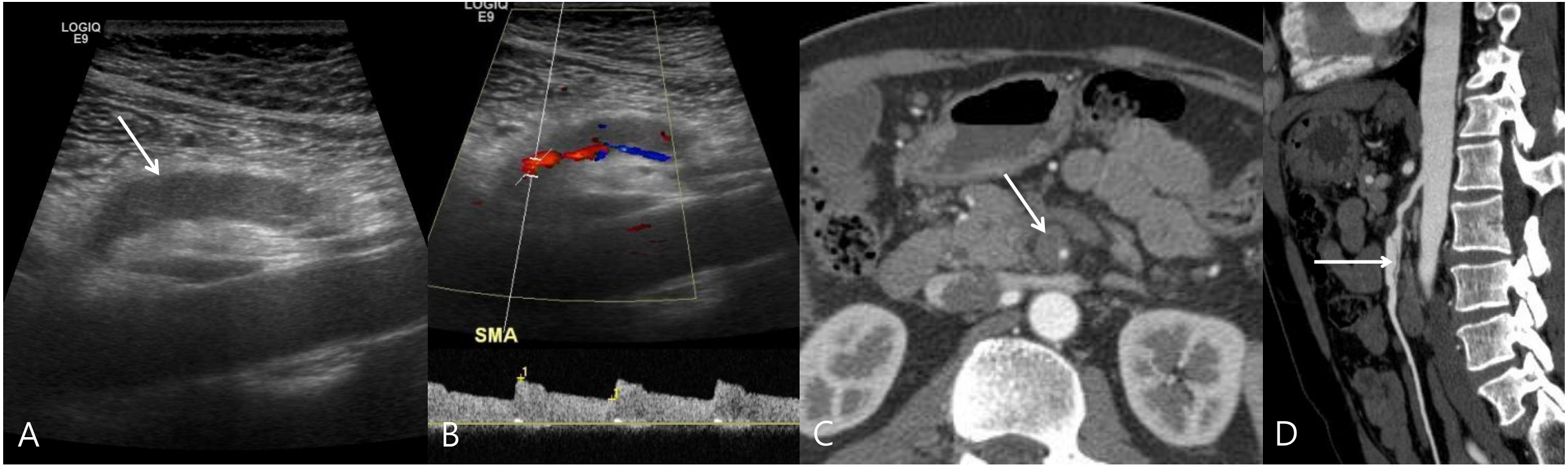


Figure 8. A 57-years -old male with SMA dissection with thrombosis(arrow). A-B. Longitudinal gray scale and color Doppler US show proximal thrombosis with luminal narrowing. C. Axial CT scan shows luminal narrowing with thrombosis of SMA(arrow). D. Curved MPR shows a dissection flap(arrow) in the SMA with proximal thrombosis.

NOMI (Non-occlusive mesenteric ischemia)

- NOMI comprises all forms of mesenteric ischemia without occlusion of the mesenteric arteries and accounts for 20–30% of all cases of acute mesenteric ischemia. Hypoperfusion of peripheral mesenteric arteries can be caused by different mechanisms and the risk of developing NOMI increases with age. Cardiovascular and drug related factors are risk factors and also various forms of shock, septicemia, dehydration and hypotension following dialysis and heart surgery or major abdominal surgery. During low flow states, the entire intestine can be damaged, but the small intestine and the right colon seem to be more sensitive to the states of shock.
- US findings in the early phase are non-specific and poor indicative as thin layer of abdominal free fluid, or signs of parenchymal ischemia (not always present); in the intermediate phase the bowel wall thinning and the following hypotonic reflex ileus could be found if there isn’t reperfusion; if the blood pressure is recovered and there is reperfusion damage, bowel wall thickening, hypotonic reflex ileus and gas fluid mixed stasis could be found. In the late phase, when there is severe necrosis of bowel wall, fluid collections and intramural gas could be seen.

NOMI (Non-occlusive mesenteric ischemia)

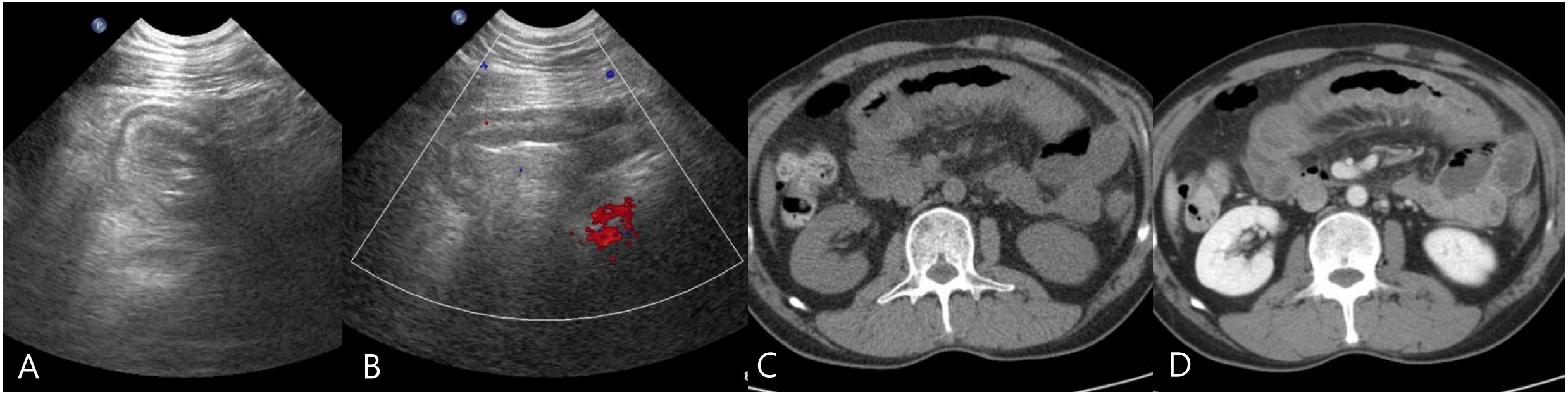


Figure 9. A 44-years-old male with small bowel infarction without occlusion of mesenteric vessels. A. Gray scale US shows small bowel wall thickening without vascular flow within the bowel wall on CDI (B). C. Non-contrast CT shows thin high attenuation lines along the inner wall. D. Postcontrast CT shows segmental wall thickening with air accumulation in the lumen. Pathologic diagnosis is hemorrhagic small bowel infarction.

Ischemic Colitis(IC)

Ischemic colitis refers to inflammation of the colon secondary to vascular insufficiency and ischemia. The left hemicolon from the splenic flexure to the sigmoid colon is the most frequent localization of IC. IC can show variable finding of US and CT, according to disease stage, and severity. A sudden transient from the normal colon to the hypoechoic thickened ischemic segment is a typical US sign. In the acute stage of disease, the bowel wall layers are less distinctly differentiated and color flow is barely visible. In the subacute stage increased vascularity is a good prognostic sign. IC should be suspected in elderly patients if wall thickening is combined with reduced vascular flow.

Ischemic Colitis(IC)

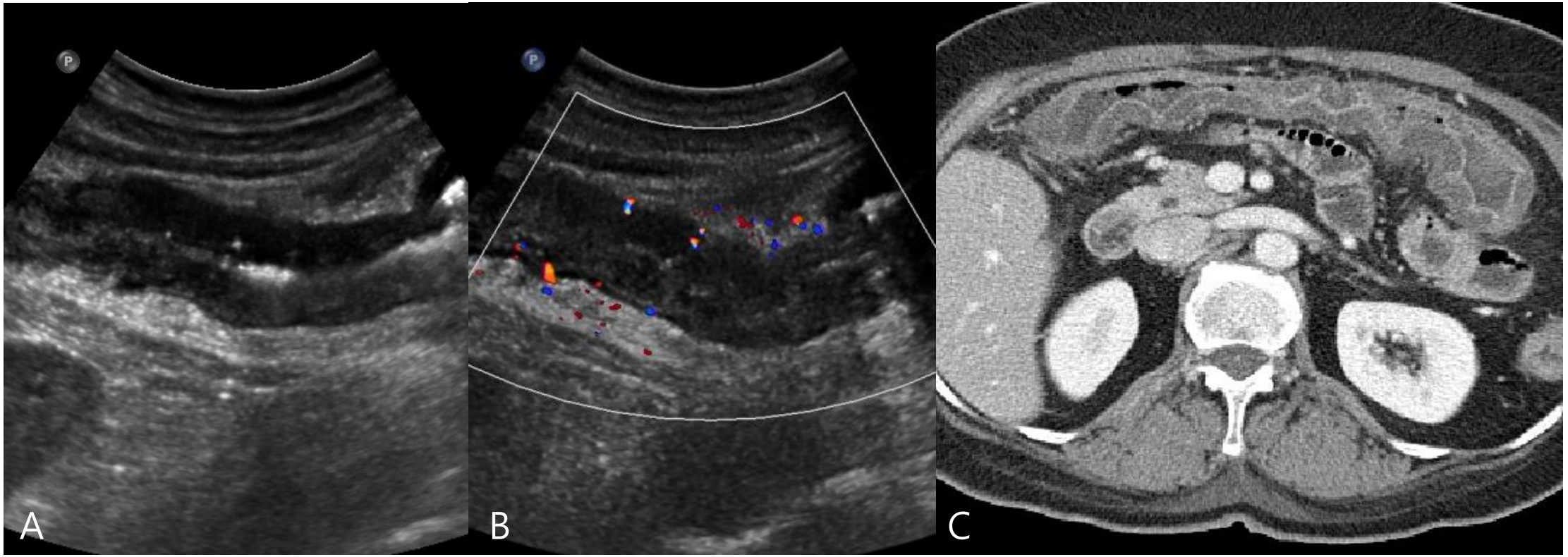


Figure 10. A 66-years-old male with ischemic colitis. A. Gray scale US shows marked wall thickening of splenic flexure of descending colon with indistinct stratification. B. CDI shows only few vascular flow within the thickened colonic wall. C. Axial and coronal scan of enhanced CT show marked wall thickening of splenic flexure, especially submucosal thickening.

Thank you