

Is contrast-enhanced ultrasound (CEUS) useful for the emergency radiologist?

Jiménez Restrepo, David; Ripollés González, Tomás; Martínez Pérez, M^a Jesús.

Department of Radiology, Doctor Peset University Hospital, Valencia - Spain.

OBJECTIVE:

Reviewing the usefulness of contrast-enhanced ultrasound with patients suffering an urgent pathology, showing clinical situations where this method is useful in order to improve the quality of the diagnosis.

SUBJECT REVIEW.

Ultrasound is the initial technical assessment of the emergency condition in many hospitals, especially in pain at the right hypochondrium, right iliac fosse, renal fosse, minor abdominal trauma and acute scrotal pain.

CEUS means an added tool in the conventional ultrasound study that let us to reach earlier to the patient diagnosis with a high reliability. Actually micro bubbles are used as ultrasound contrast due to the specific answer that the sound produced over them. The differentiation of the sign from the bubbles and the tissues is the base of the specific image contrast.

It's possible to explore the contrast that circulates through blood in the different vascular phases in the required organ with ultrasound scan and specific software. Is easy to use, it only takes some minutes for being used and the side effects are minimum

Advices in emergencies according to the organ to study:

Liver: Is the organ where there are more indications for a contrast ultrasound. It has special characteristics due to its double vascularization through the hepatic artery and the portal vein. The accurate diagnosis increases in 85%-92% when CE is used.

Abscesses: They show peripheral ring enhancement in the arterial phase, being a hyper or isoechoic ring in hypoechoic lesion in the portal venous phase, with septum enhancement or in hepatic segment.

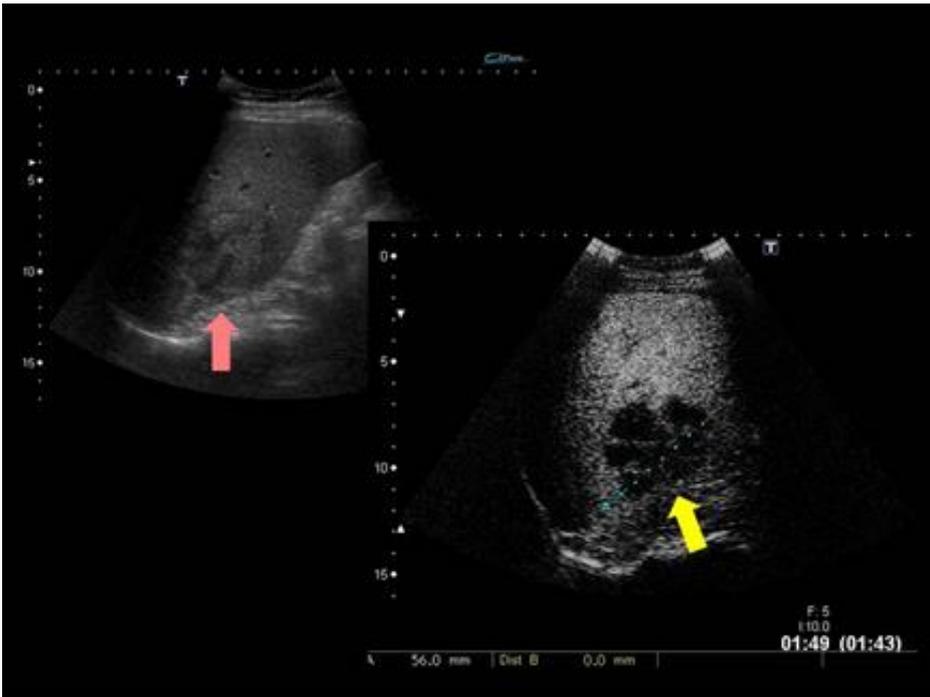


Figure 1: liver abscess. Area nonspecific heterogeneous echogenicity in the liver parenchyma (pink arrow). With a rounded area CE low boost (yellow arrow), a finding consistent with liver abscess is delimited.

There are technical limitations when we found subdiaphragmatic or deep lesions what makes difficult the analysis.

Bile duct:

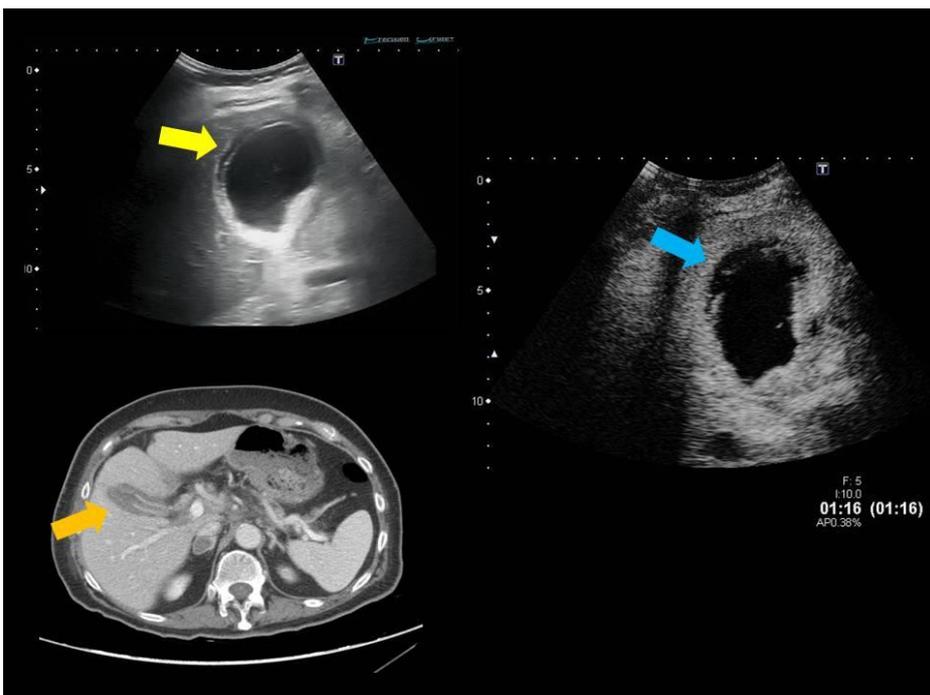


Figure 2. The ultrasound showed thickening of the gallbladder wall, corresponding to acute cholecystitis (yellow arrow). The EC revealed little enhancement in a small section of the wall (blue arrow), indicating perforation as seen on CT (orange arrow).

Is so useful in the differentiation between the biliar mud and neoplasia. A better wall marking out and the hole sign, just like the adjacent collections presence.

Malignant lesions: a faster washing (from 35 seconds) and the wall's destruction.

Ultrasound is the patient's election technique with obstructive jaundice; it confirms and tells the obstruction level. The intrahepatic bile duct dilation with a normal hepatocholedochus suggests Klatskin tumor. However, most of these tumors are isoechoic and they can enhance in the arterial phase, but in almost all the case they wash in the portal and late phase. When they are located in the basal ultrasound, the contrast increases the size delimitation and the portal affectation.

Pancreas: Is an organ with a vascular provision mostly arterial and its characterized for having a precocious enhancement and a quick wash in order to establish an optimum form hypo an avascular lesions. It also has a better efficiency identifying peripancreatic collections.

In acute pancreatitis, the necrosis zones are hypoperfused, and the ones of the focal pancreatitis are normopefused.

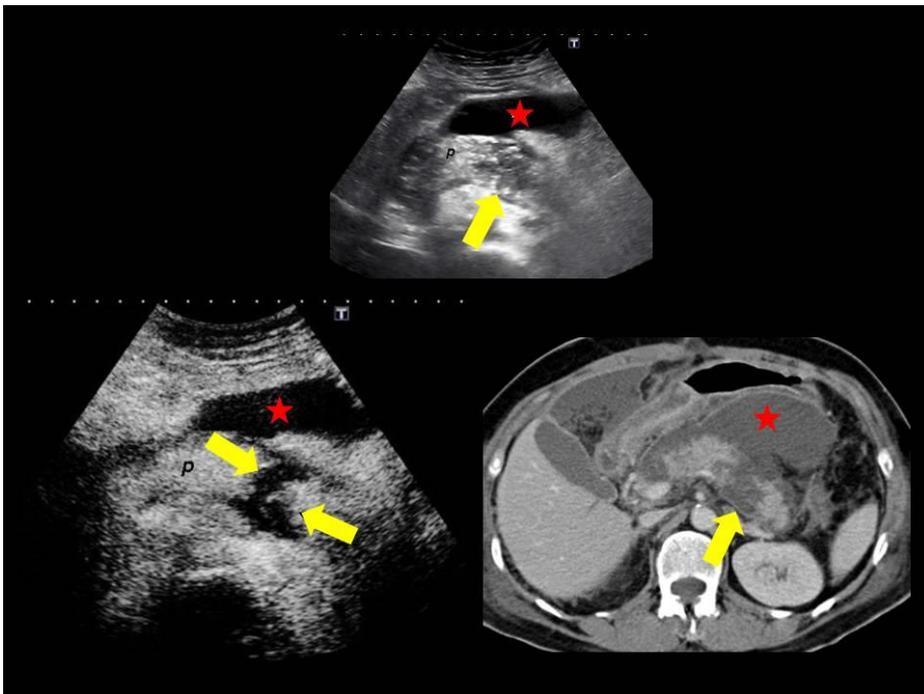


Figure 3. With ultrasound pancreatic parenchyma was found heterogeneous, hypoechoic area (yellow arrow) and a fluid collection in the lesser sac (red star). The EC demonstrates a lack of enhancement area corresponding to necrosis. The same findings are seen on CT performed 48 hours later.

Kidney and urinary tract: Kidney has an intense precocious arterial enhancement of the normal parenchyma that is why it gets easier the diagnosis of vascular lesions.

The infarcts are shown due to the enhancement absence, and the cortical necrosis is also shown. It's so useful in kidney transplantation.

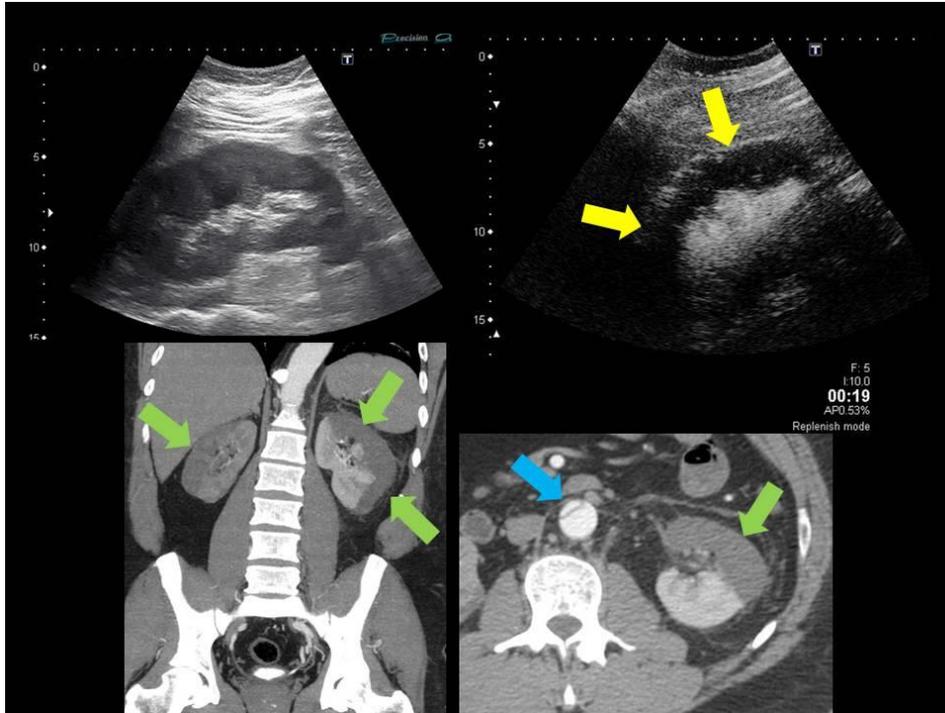


Figure 4. Without ultrasound findings. With EC shows little enhancement of the left kidney parenchyma (yellow arrows). CT showed little enhancement in both kidneys (green arrows), being more severe in the right kidney. Aortic dissection was confirmed by CT + C (blue arrow).

The kidney masses characterization is a very clear indicator of the CE. It's more useful in classified lesions like Bosniak categories IIF, III, or IV.

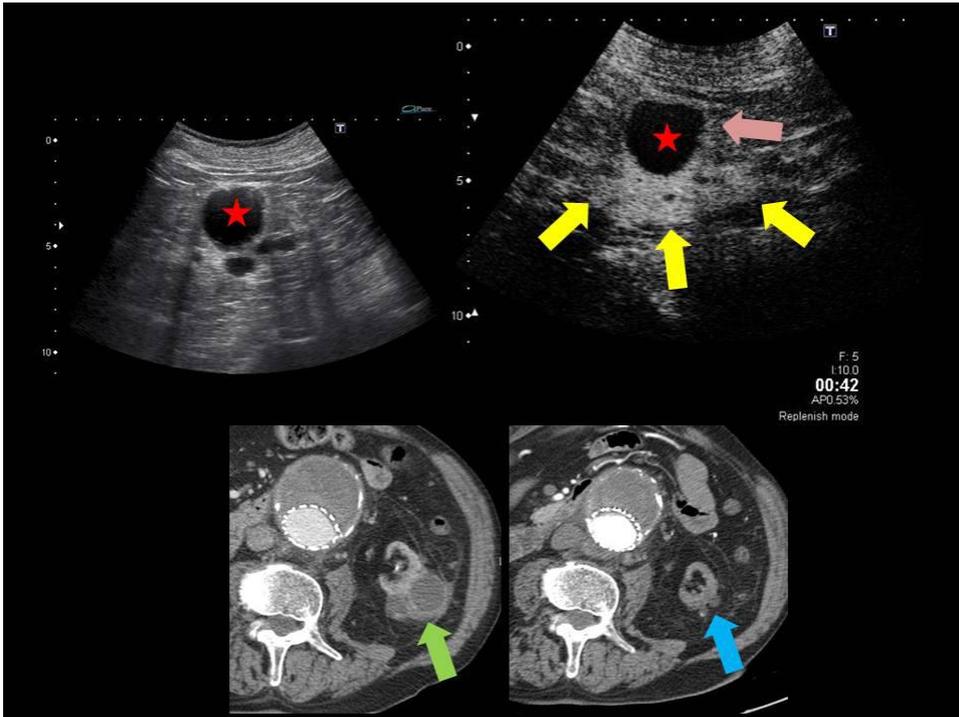


Figure 5. Ultrasound identified with difficulty the parenchyma of the left kidney cysts observed (red star). With CE renal parenchyma was identified more accurately (yellow arrows), and thickened walls cysts (pink arrow), a finding in relation to inflamed cyst. TC within days: cysts with thickened walls (green arrow). TC several months later disappearance of signs of inflammation (blue arrow).

The focal Nephritis is shown like less enhancement areas than in the normal kidney tissue adjacent, with a variable triangular, linear, or rounded form. They are different from the abscesses that are shown with enhancement absence in all the phases and a changeable presence of a peripheric enhancement

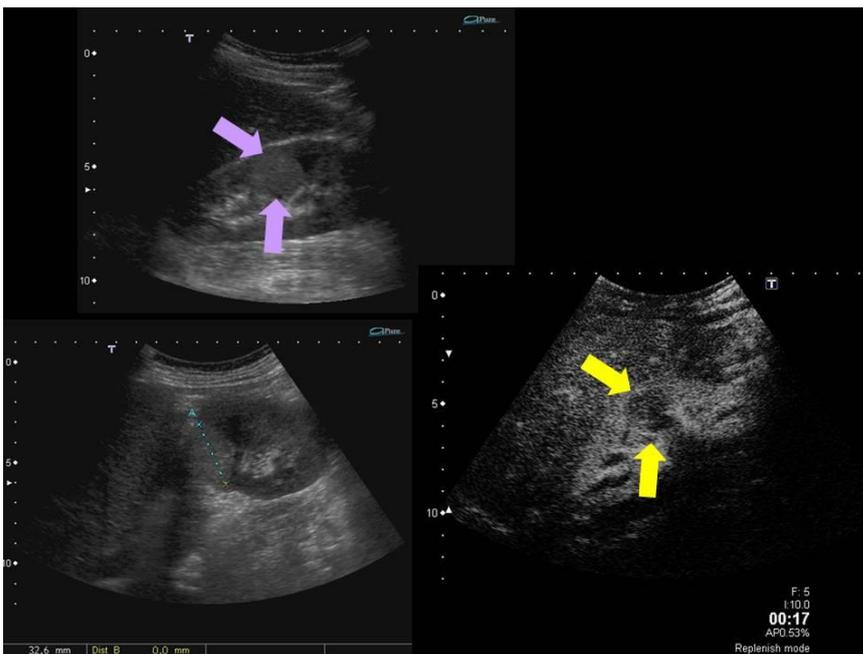


Figure 6. Area subtle hyper echogenicity observed in the renal parenchyma (pink arrows). The ultrasound confirms the absence of contrast enhancement in that location, corresponding to focal pyelonephritis (yellow arrows).

Intestine: Difference between phlegmon and abscess in the appendicitis, diverticulitis or Chron's disease. It is useful in simulated pathologies (epiploic appendicitis, omental infarction) and it determines viability of the handles in the obstructive pathology, ischemic, hernias or Ischemic colitis.

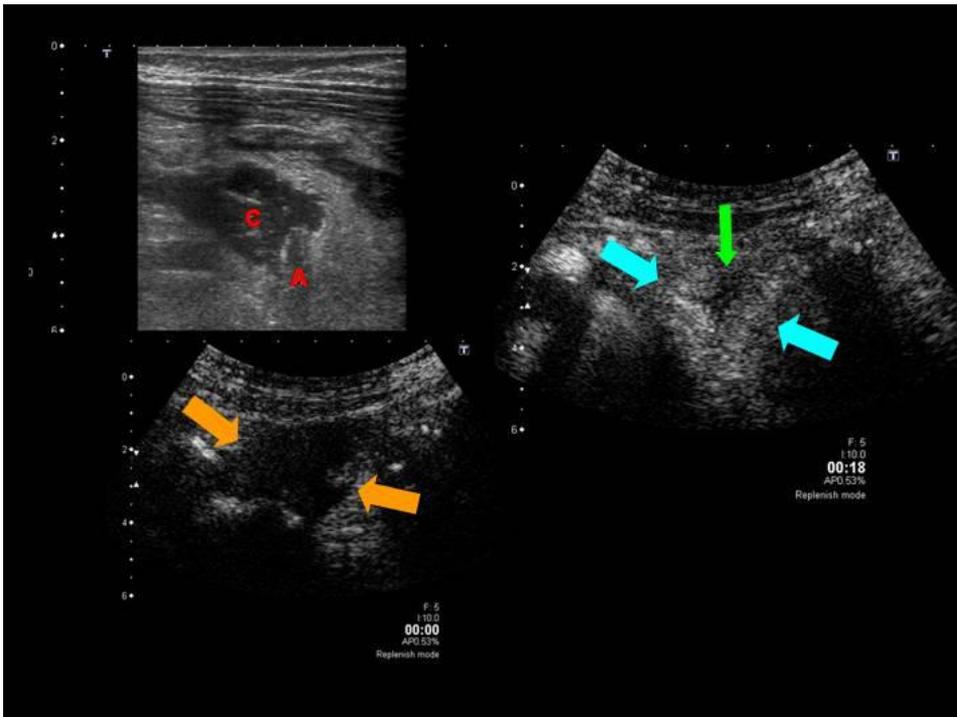


Figure 7. Ultrasonography confirmed appendicular inflammatory signs (A), and also heterogeneous periappendiceal area initially interpreted as a collection. Most initially hypoechoic area (yellow arrows) showed enhancement, corresponding to an abscess (blue arrows). A small abscess persisted (green arrow).

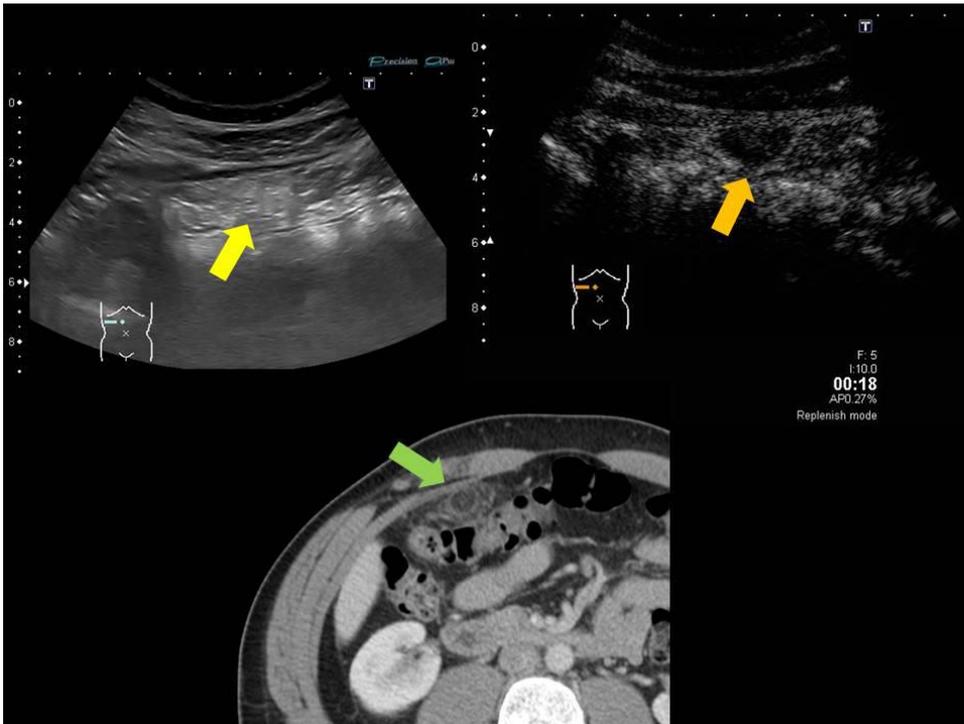


Figure 8. The ultrasound showed a hyperechoic area of mesenteric fat (yellow arrow). With CE shows increased enhancement of fat in that location and a central area without highlighting for omental infarction (orange arrow). Contrast-enhanced CT image muetra (green arrow).

An important indicator is to determine the activity of the known intestinal inflammatory disease, particularly in the Chron's disease, showing the mucosa and submucosa layers enhancement

The patients that have stenosis of the intestinal lumen and the resulting intestinal mechanical obstruction, it is important to determine if there is an inflammatory activity in the stenosis place or if the stenotic segment is fibrotic. With CE the inflammatory activity shows enhancement while the fibrotic scar don't.

Traumatism: It can be used in minor abdominal trauma, in the detection of parenchymal lesions active bleeding or pseudoaneurysm presence.

The lacerations and hematomas in the abdominal solid organs are identifying as absence enhancement zones in comparison to the normal peripheral parenchyma. The active bleeding is visualizes as hyperechoic focus from the precocious phase and It's accumulated the CE in the parenchyma or the hematoma. The pseudoaneurysm are also hyperrecogenic, they are visualized since the beginning of the study but with round form.

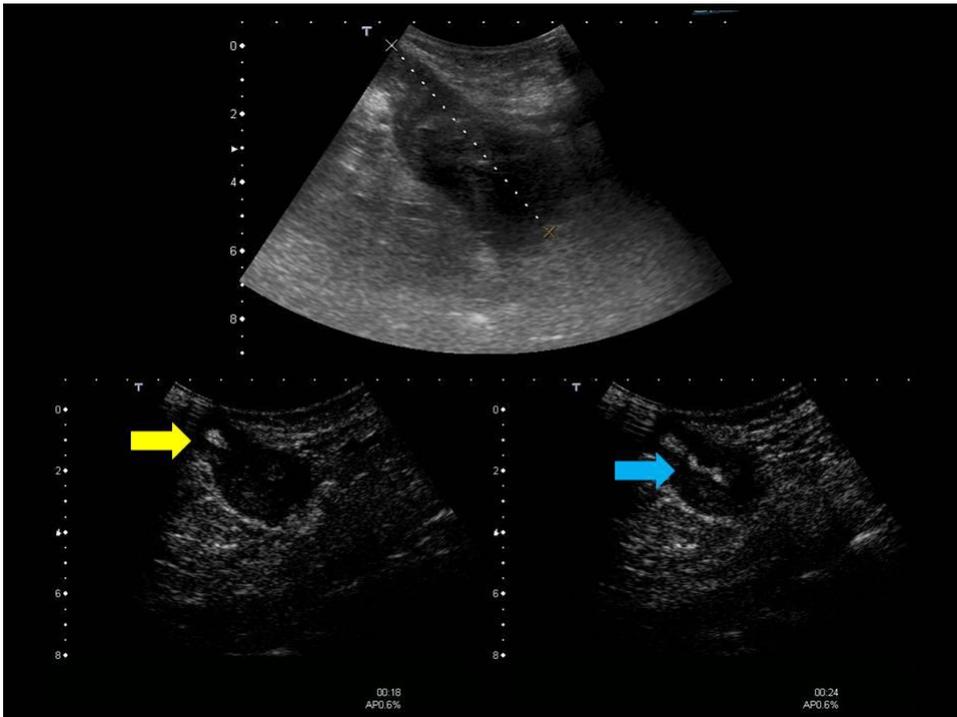


Figure 9. The ultrasound showed a heterogeneous collection in the abdominal wall, corresponding to a hematoma. With CE revealed non-enhancing area within the arterial phase hematoma (yellow arrow), which became linear in seconds (blue arrow): Finding regarding active bleeding.

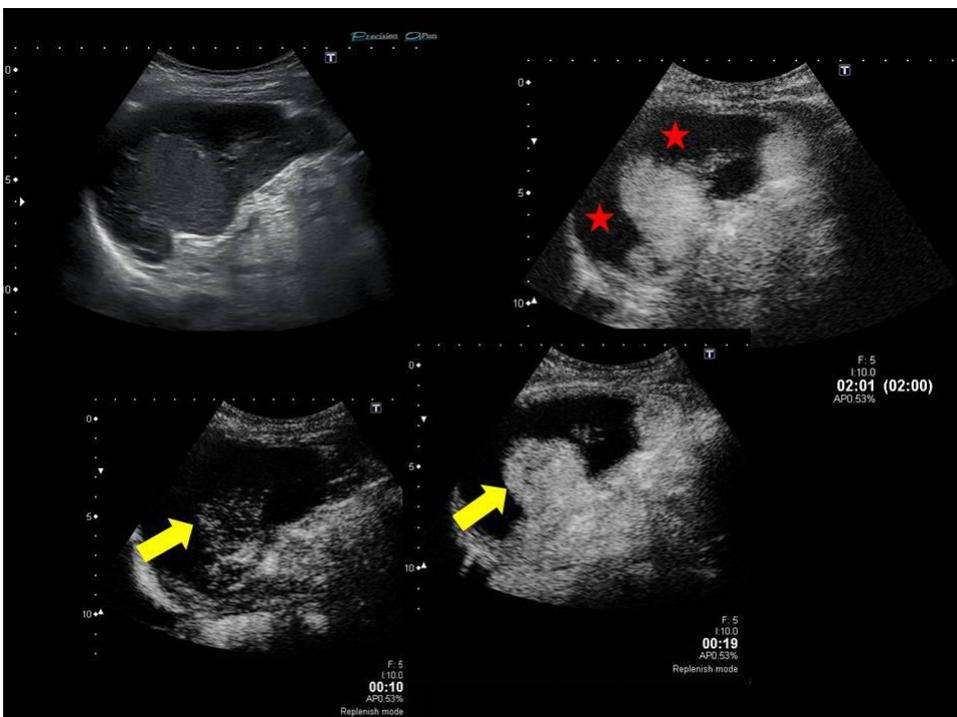


Figure 10. The ultrasound revealed a heterogeneous splenic parenchyma. With CE shows a normal enhancement in the arterial phase, only the central portion of the spleen (yellow arrows), and little enhancement in the rest of the parenchyma, even in the late phase (red stars). Findings for spleen necrosis liquefactive.

Aorta: aortic endoprosthesis control, where one of the complications are the endolakes, is essential its detection due to if it is not treated, it can lead to the progressive aneurism extension, having the break risk. For this purpose the endolake detection with CE has an advantage over the TC, due to the lack of exposure to nephrotoxicity, a typical factor in the patients with vascular disease, and their renal function is modified, and the findings are similar to the one visualizes in the TC.

CE: in the type II, the most common (for retrograde flow from collateral aortic vessels, lumbar arteries or AMI) the enhancement is slow in the sac and it's visualized after 2 minutes. This slow filling explains why the ultrasound sensibility is higher than the TC. Most of the times the sac is filled in a diffused form.

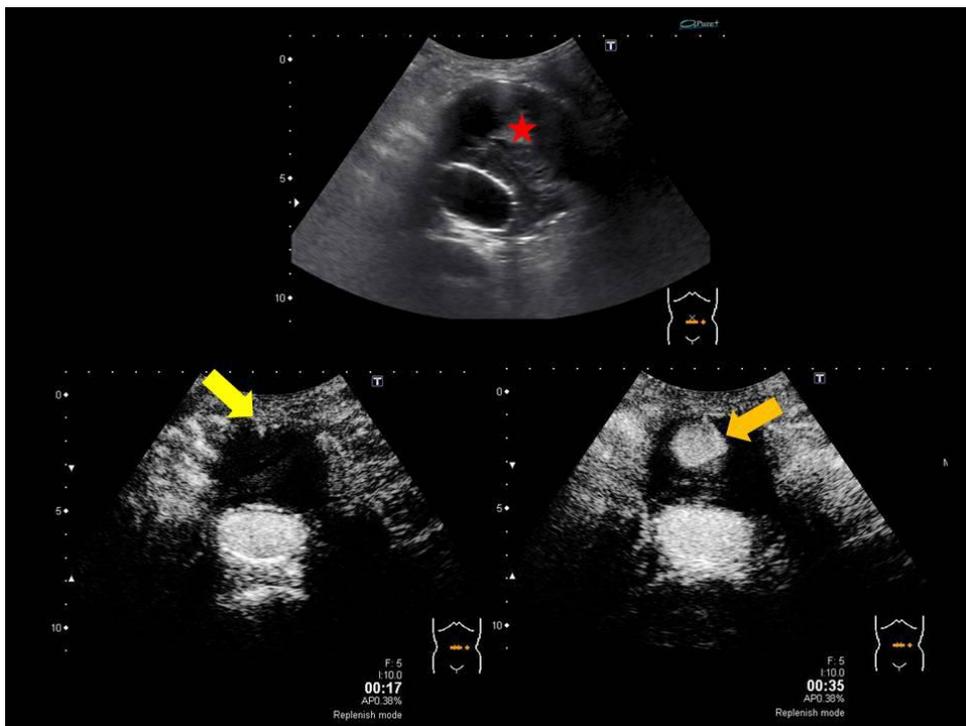


Figure 11. Ultrasound shows an abdominal aneurysm with clot (red star). With CE demonstrates an area of enhancement within the aneurysm (yellow arrow) that grew during the arterial phase (orange arrow), corresponding to type 2 endoleak.

Scrotum: In the acute scrotum increases the trauma valuation or enlargements, being useful in the torsion cases with no conclusive ultrasound or in the differentiation among tumors abscesses and enlargements.

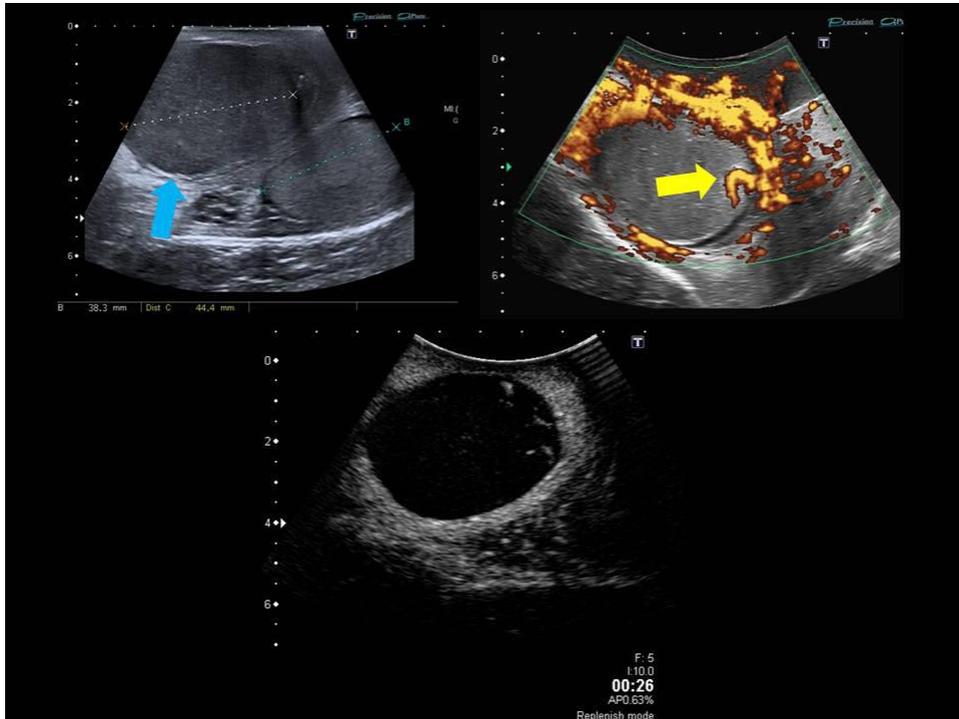


Figure 12. . In the ultrasound was found enlarged right testicle (blue arrow) with decreased parenchymal vascularity in the Doppler study, however, blood flow was observed in some vessels (yellow arrow). CE: Shows lack of enhancement around the right testicle.

Gynecological adnexal disease: Although it is not shown its usefulness in the ovarian masses characterization, the CE image has a bigger focus in the differentiation of the benign adnexal disease over the malign. The blood flow inside the complex septum and nodules of the ovarian complex, it confirms neoplastic disease exceeding the doppler study even if they are done with endovaginal technique.

CONCLUSIONS:

Contrast-enhanced ultrasound is an effective and safe technique. It should be considered as a complementary technique for ultrasound, in order to resolve doubts, allowing a more reliable final diagnosis and thus reducing the number of additional explorations.

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