Contrast Enhanced US for evaluation of Liver Lesions

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Introduction

- **Contrast enhanced US agents have been widely used for evaluation of liver and renal lesions, particularly if CT/MRI are contraindicated.**
- **There is no radiation risk and can be used safely in pediatric patients.**
- **With CEUS, the background tissue can be eliminated, providing a truly vascular image, with superior visualization of small structures such as septa and mural nodules**
- **There are not hepatotoxi nor nephrotoxic, there is no need for renal function assessment prior to the study.**
- **These agents are partly metabolized by the liver and eliminated by the lungs after 20 mins from administration.**
- **No serious side effects have been reported.**
- **Can be done more than one time in the same session.**

Dynamics

- CEUS agents are purely intravascular they don't extend to the interstitial space (as seen on CT/MRI contrast agents).
- Based on the above fact, the dynamic phases for CEUS are as the following :

Phase	Start[a] (s)	End[a] (s)
Arterial phase	10–20	20–35
Portal venous phase	30–45	120–180
Late phase	120–180	240–360[b]

Assement:

CEUS are purely intra-vascular, they can show the true characteristics of each liver lesion based on their vascular supply regardless the appearance of the background liver (which is one of the challenges seen on B mode imaging).

B mode assessment should always be performed.

The lesions are described as hypo, hyper or iso enhancing relative to background liver.

Washout of a lesion is compared to the adjacent liver parenchyma during any phase.

The presence of contrast washout is the main imaging feature of malignancy, whereas its absence suggests benignity.

Pitfalls

- Large gauge cannula should be placed as small cannula will destroy the microbubbles.
- Difficult to assess more than two lesions in one settings.
- Avoid prolonged insonation : as it will lead to microbubble destruction (it depends on the duration and transducer frequency).
- Microbubble destruction leads to signal loss and the appearance can be wrongly misinterpreted as washout.

Can we repeat the test?

- A. **Wait for the contrast to be cleared after(10-30 mins)**
- B. **Use flash technique** (not recommended) :
- 1.**Applying high mechanical index:** to quickly burst the microbubbles and clear the imaging field.
- 2.**To be followed by low-power pulses** to show lesion replenishment..
- 3. The technique is not recommended as it will make the imaging field inhomogenous.

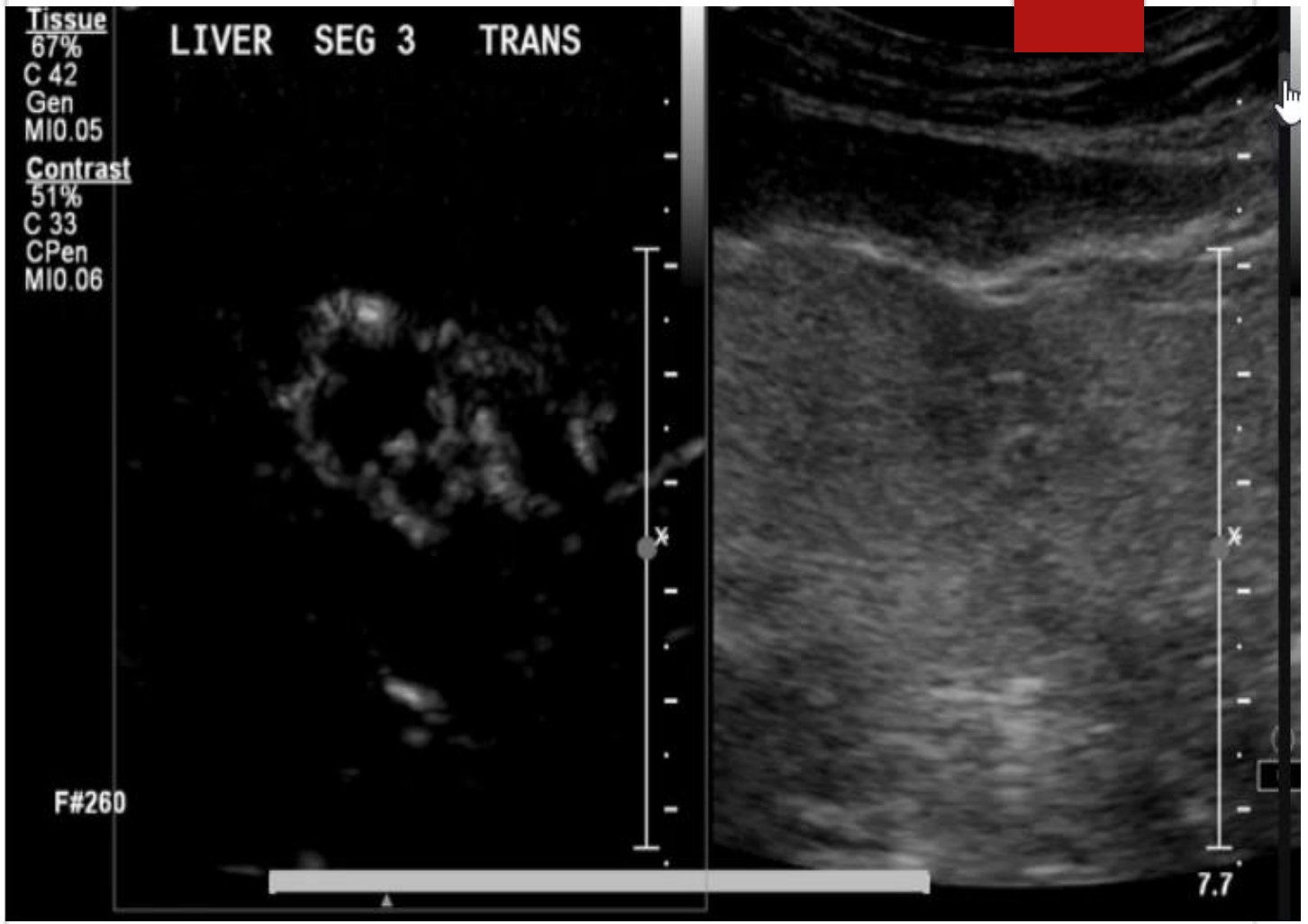
Hemangioma

- **B mode appearance** : hyperechoic (but can appear hypoechoic if the background liver is abnormal).
- The typical CEUS pattern is:

1. **Arterial phase**: globular peripheral enhancement with progressive centripetal filling .
2. **Late phase** : the lesion is persistantly hyper- or isoechoic **(never hypoechoic**).
3. Unenhanced areas in the portal and late phases of hemangiomas represent intralesional thrombosis or fibrosis.

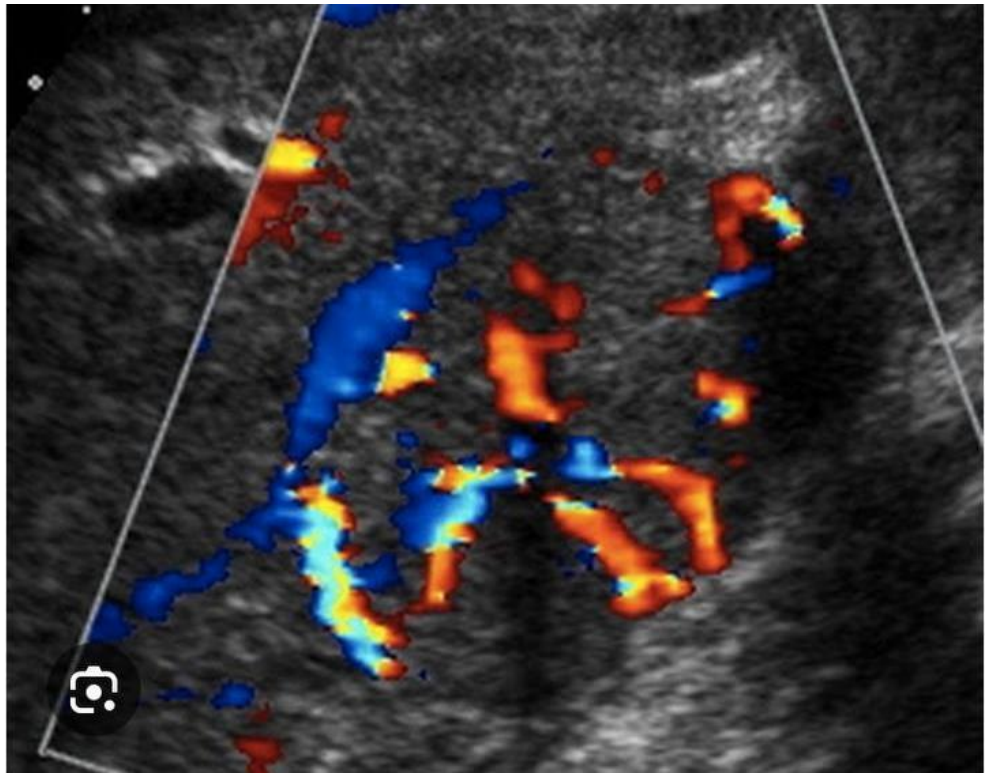
- **This pattern is considered diagnostic of hemangioma whatever the B-mode appearance of the lesion .**

- Note that the lesion is hypoechoic on the B mode setting due to background increase in the liver echogenicity, but the dynamic enhancement is characteristic of hemangioma.



FNH

- Typical pathologic feature : **a large central (sometimes peripheral) fibrous scar in which large artery is located**
- **B-mode : non specific**, slightly hyperechoic, slightly hypoechoic, isoechoic, or slightly inhomogeneous.
- The central scar and radiating fibrous septa can usually (70–80% of cases) be identified as linear hyperechoic structures.
- **Color doppler appearance : The central vessel radiating from the center to the periphery** (a highly specific finding) can be identified at baseline color Doppler ultrasound.



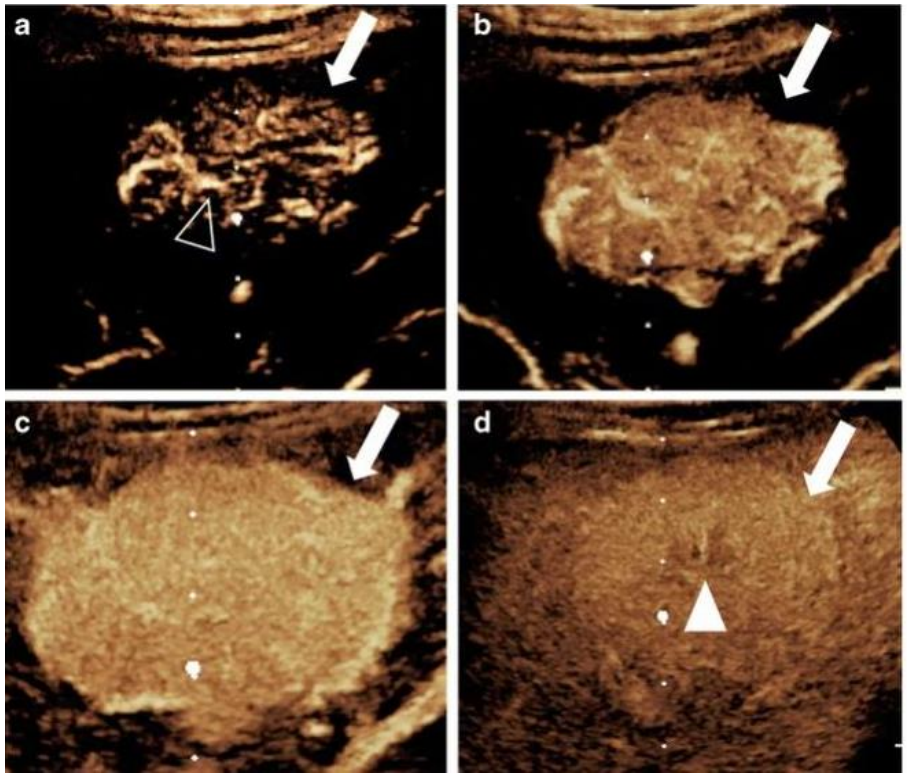
FNH

- CEUS:

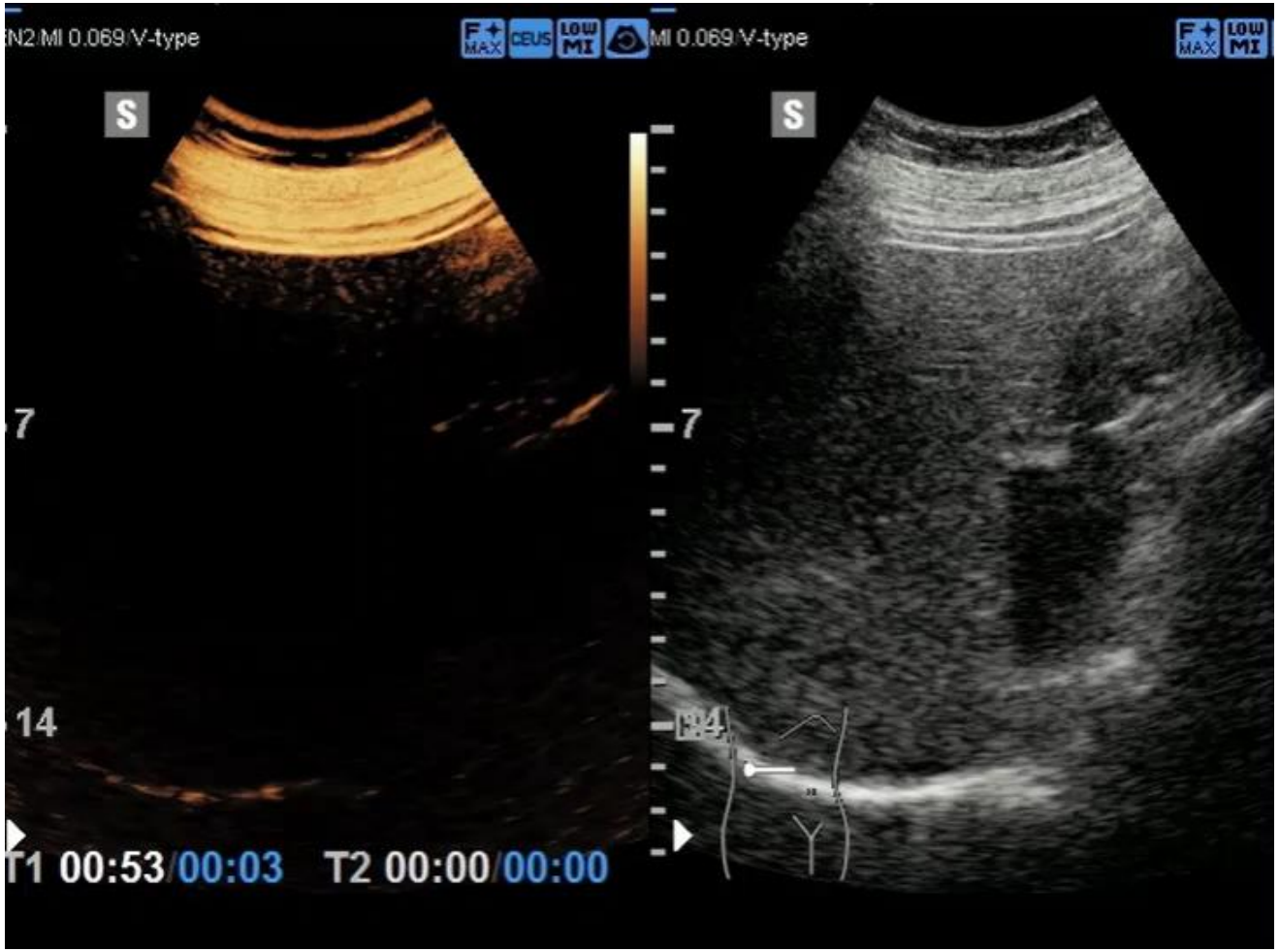
I. **Presence of a central feeding artery** that is visible in the early arterial phase

II. **Then demonstrates a centrifugal filling pattern with stellate (spoke-wheel) hyperenhancemen**t in the arterial to early portal venous phases,

III. **Iso-or hyperenhancement in the late portal venous phase** with hypo-enhancing scar



FNH



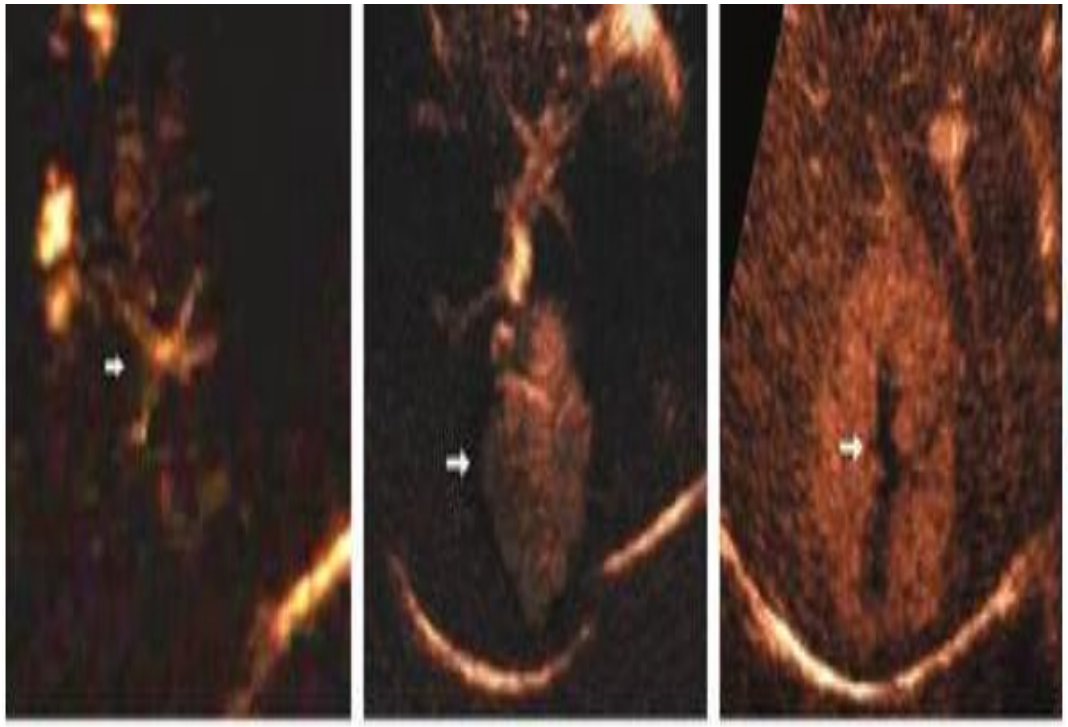
Adenoma

CEUS :

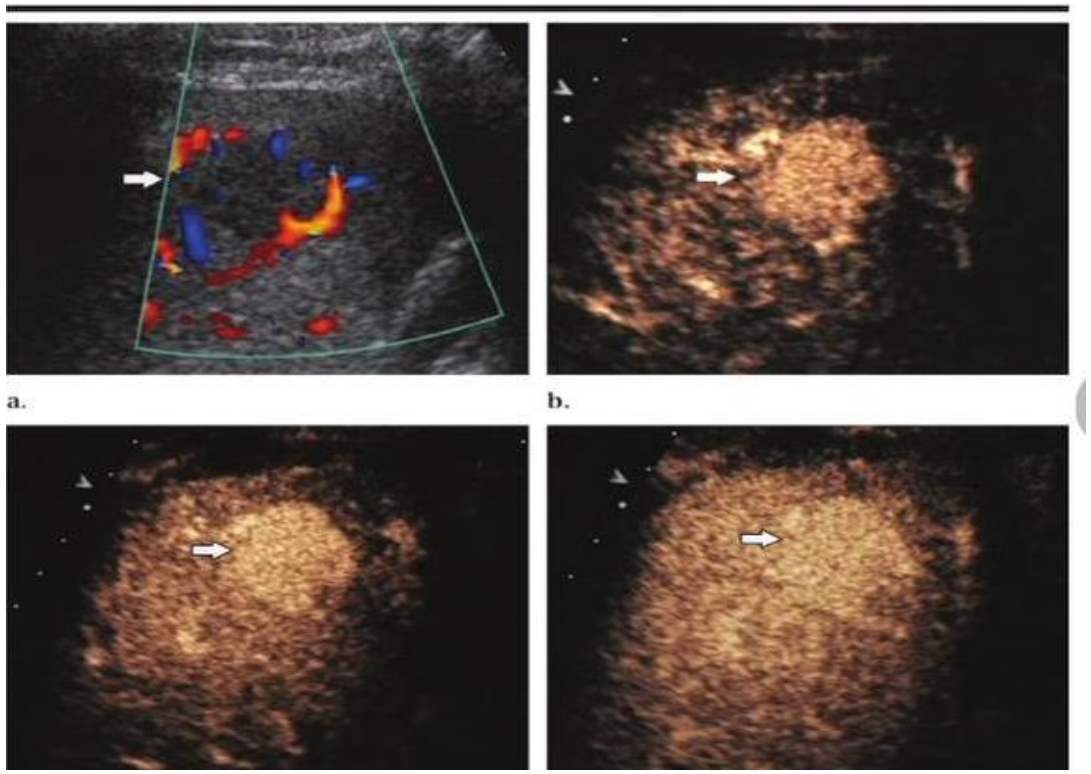
1. Arterial phase **: shows homogeneous contrast enhancement in the, typically with rapid complete centripetal filling.**
2. In the early portal venous phase**, it usually becomes isoechoic** or, more rarely, remains slightly hyperechoic.
3. **Intratumoral nonenhancing areas are due to previous bleeding episodes or to necrotic portions**.

The absence of spoke wheel enhancement will differentiate it from FNH and this is quite important in terms of Mx (adenoma has risk of bleeding, malignant degeneration and surgical resection should be considered).

FNH with spoke wheel enhancement



Adenoma with centripetal enhancement



Malignant Liver lesions

The main feature of malignancy is washout on the late phase

- **Washout can be assessed according to degree and onset (according to CEUS LIRADS Group)**

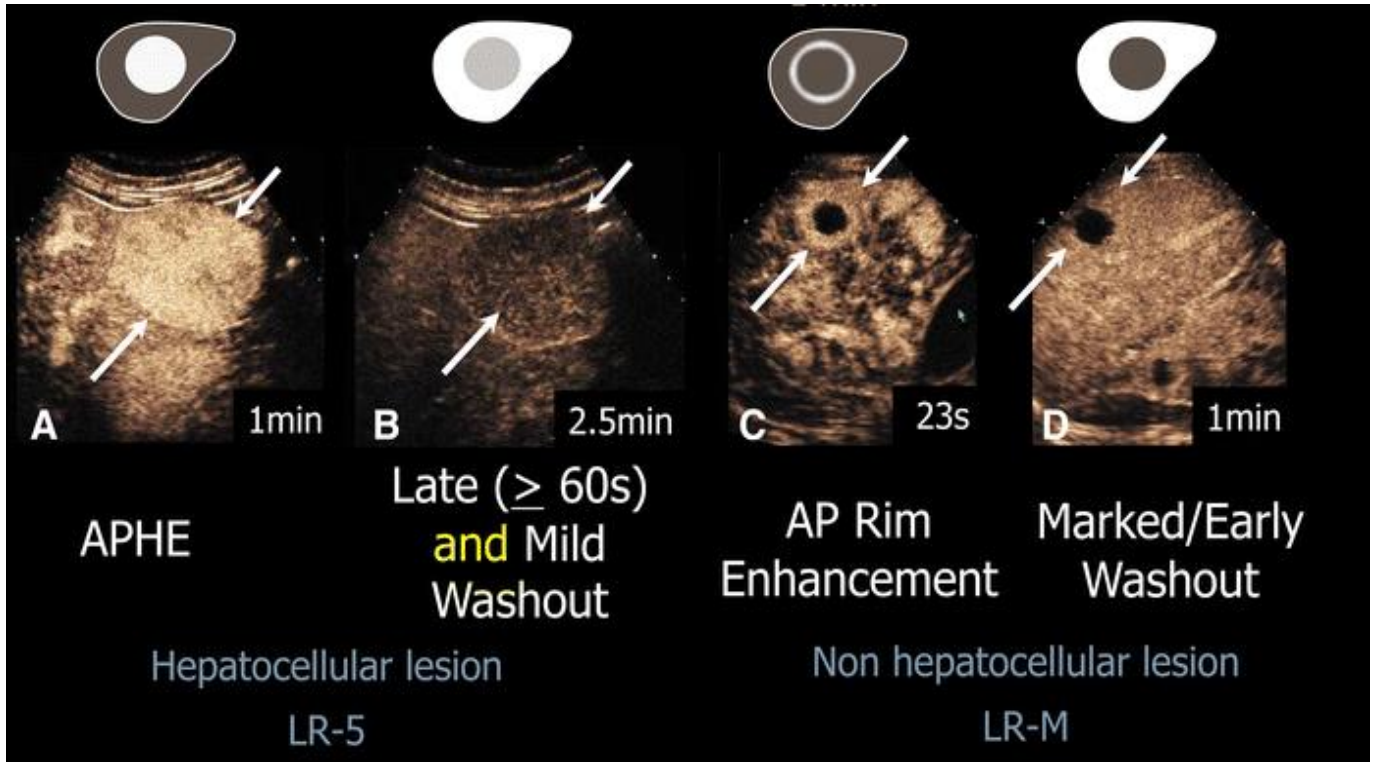
Onset: time after contrast injection in seconds when washout is first detected
- **early: < 60 seconds after injection**
- **late: ≥ 60 seconds after injection**

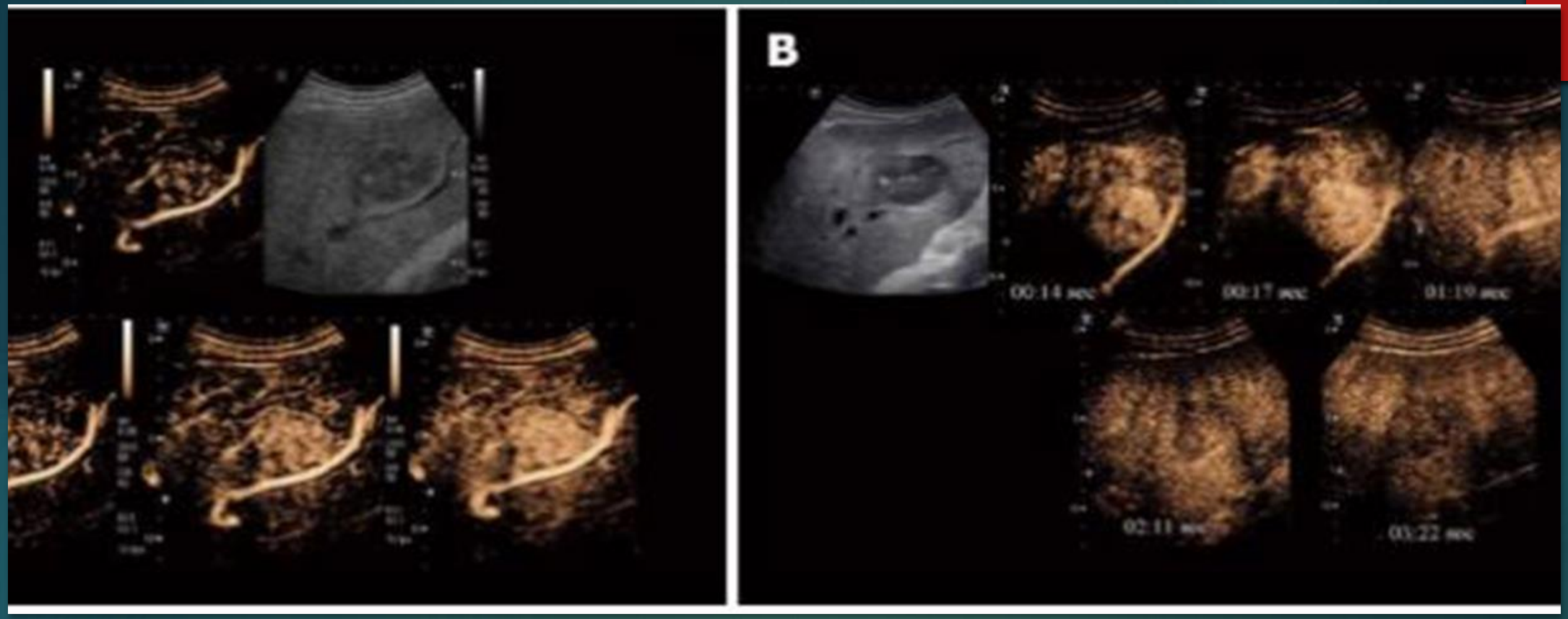
Degree: comparing nodule to background liver at 2 minutes after contrast injection

Marked: nodule devoid of enhancement "punched-out" by 2 minutes
Mild : nodule less enhanced than liver, but not devoid of enhancement at 2 minutes

Interpretation of washout:

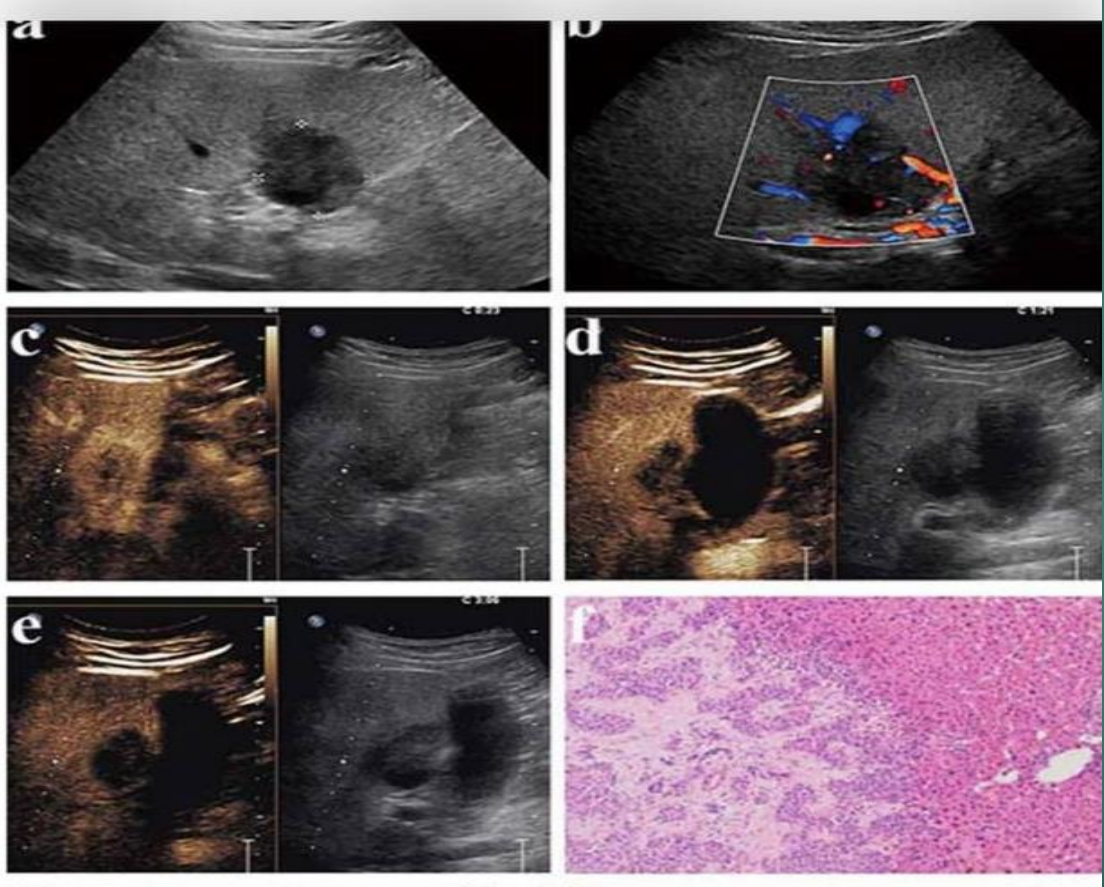
- Early marked: typical of intrahepatic cholangiocarcinoma and metastases
- Late mild: typical of HCC and HCC precursor nodules•
- early mild and late marked are suggestive of malignancy in general, not specific for type





HCC : EARLY ARTERIAL ENHANCEMENT AND LATE MILD WASHOUT

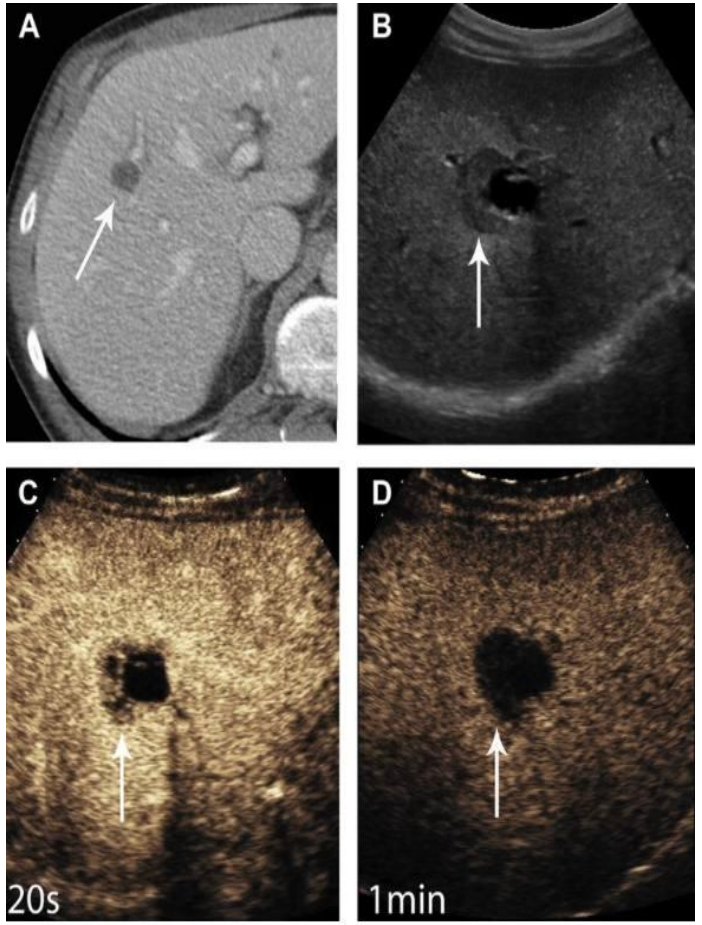
Cholangiocarcinoma



(**c**) During the arterial phase (23 s), the lesion exhibits heterogeneous hyperenhancement; (**d**) During the portal venous phase (81 s), the lesion exhibits hypoenhancement of its interior with hyperenhancement in the peripheral region, resulting in the formation of a hyperenhanced rim; (**e**) During the late phase (186 s), the lesion exhibits hypoenhancement; (**f**) Micrograph (original

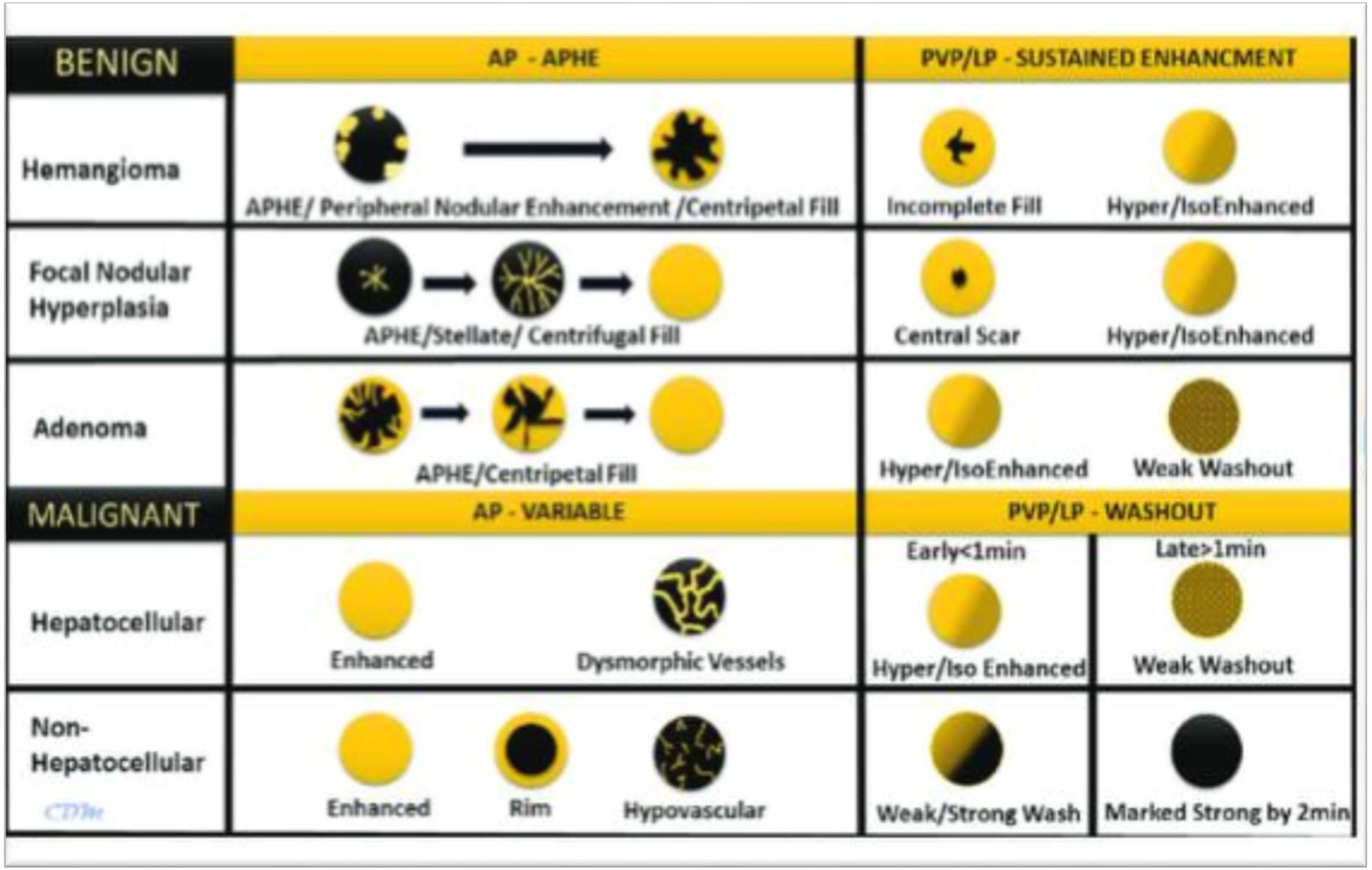
Metastasis

- The main feature is rapid washout (starting as early as one minute) with the lesion appearing devoid of contrast on the late phase (punched out).
- CEUS can help differentiate between benign cysts and cystic metastasis which show peripheral enhancement.



Cystic metastasis. (A) A portal venous phase CT image on a patient with prior pancreatic cancer resection shows an indeterminate low attenuation mass (arrow). (B) A gray-scale US image shows a cyst with a solid hypoechoic rim along 1 edge. (C) A CEUS image at 20 seconds shows enhancement of the liver. The solid rim of the cyst is slightly hypoenhanced relative to the liver. (D) There is rapid marked washout at 1 minute such that the entire complex mass now appears black. Rapid marked washout by 1 minute is classic for metastatic disease.

All in One


BENIGN
AP - APHE
PVP/LP - SUSTAINED ENHANCMENT
Hemangioma
APHE/ Peripheral Nodular Enhancement /Centripetal Fill
Incomplete Fill
Hyper/IsoEnhanced
Focal Nodular Hyperplasia
APHE/Stellate/ Centrifugal Fill
Central Scar
Hyper/IsoEnhanced
Adenoma
APHE/Centripetal Fill
Hyper/IsoEnhanced
Weak Washout
MALIGNANT
AP - VARIABLE
PVP/LP - WASHOUT
Hepatocellular
Enhanced
Dysmorphic Vessels
Early<1min
Late>1min
Hyper/Iso Enhanced
Weak Washout
Non-Hepatocellular
Enhanced
Rim
Hypovascular
Weak/Strong Wash
Marked Strong by 2min

Educational Resources

- https://ajronline.org/doi/full/10.2214/AJR.14.14203
- https://link.springer.com/article/10.1007/s00247-021-04976-2
- https://radiopaedia.org/articles/ceus-li-rads-2


Thank you