KREP

2025

KARNATAKA RADIOLOGY EDUCATION PROGRAM

LIVER Anatomy and applied radiology -5

A triple-phase CT scan of the liver protocol involves acquiring images during the late arterial, portal venous, and delayed phases to assess focal liver lesions and hypervascular tumors, offering detailed visualization of liver blood flow and structures.

Here's a more detailed breakdown:

Phases of the Scan:

Late Arterial Phase:
This phase, typically 35-45 seconds after contrast injection, focuses on the arteries supplying the liver, highlighting any abnormal blood flow or masses.

Portal Venous Phase:
Captured around 60-75 seconds after contrast injection, this phase visualizes the portal vein and helps identify changes in blood circulation, such as portal vein thrombosis or tumor-related obstructions.

Delayed Phase:
This phase, occurring a few minutes after the contrast injection, visualizes the liver's equilibrium state, ensuring comprehensive data capture for accurate diagnosis.

General Principles of Protocol Design:

Patient Positioning: Patients are typically scanned in a supine position with their arms above their head.

Scan Extent: The scan typically covers from the diaphragm to the iliac crests, with some departments performing a full abdomen and pelvis in the portal venous phase.

Scan Direction: The scan direction is typically craniocaudal.

Contrast Injection:

A bolus tracking method is used to determine the timing of the scans.

Monitoring slice (region of interest) is at the level of the diaphragmatic hiatus or first lumbar vertebra at the aorta.

A threshold of 150 HU is used to trigger the scan.

100-120 mL of non-ionic contrast is typically injected at 3 to 5 mL/s.

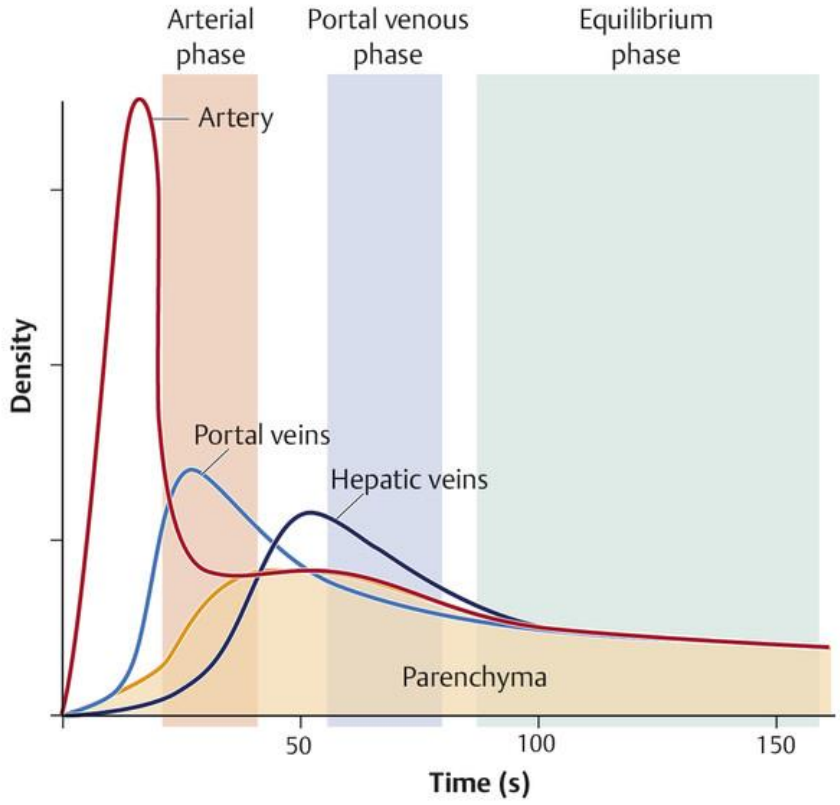
Scan Delays:

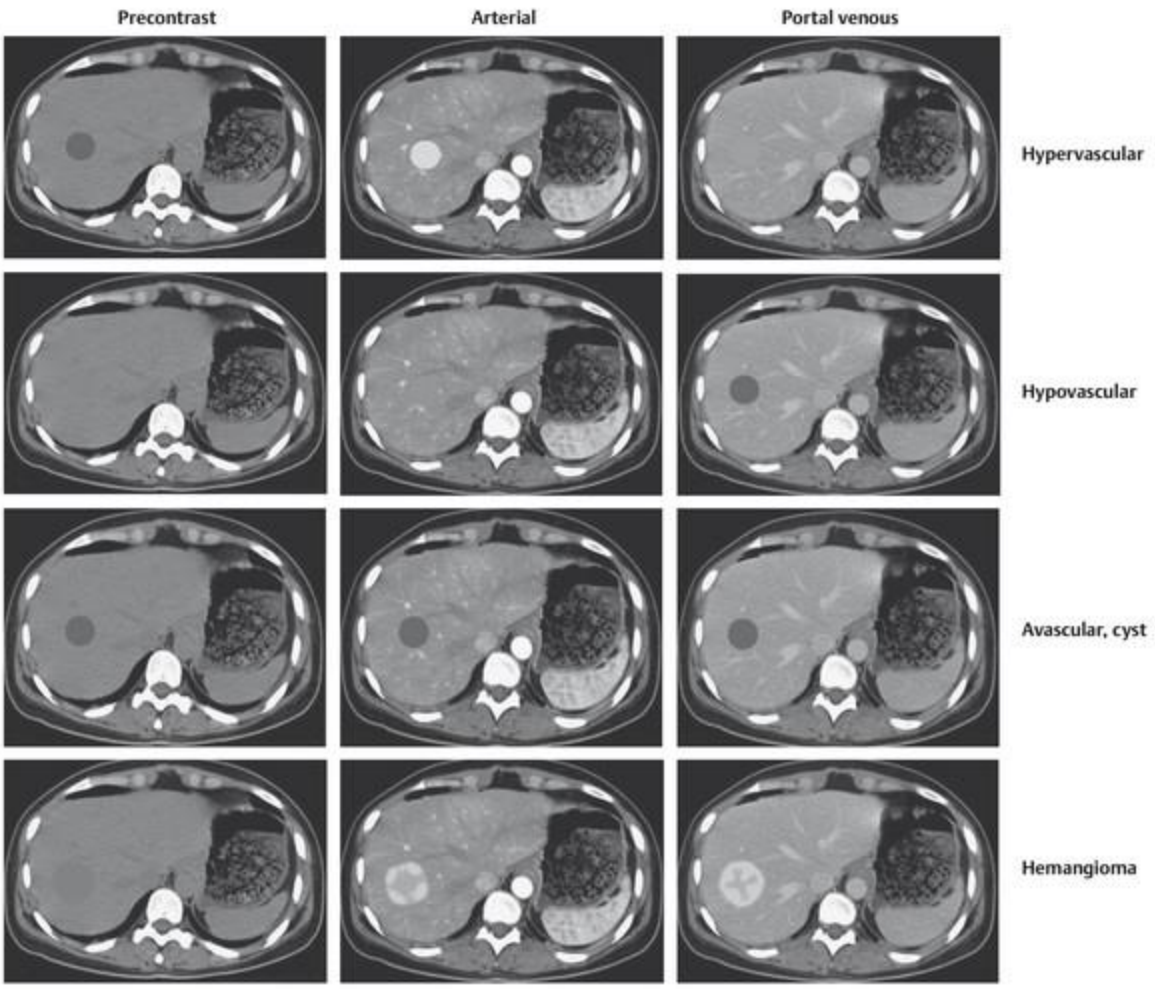
Late arterial phase: 15-30 seconds post bolus trigger (35-45 s after injection).

Portal venous phase: 60-75 seconds post-injection (independent of arterial timing).

Delayed phase: 2-5 minutes.

Respiration: Breath-hold during inspiration is typically used.



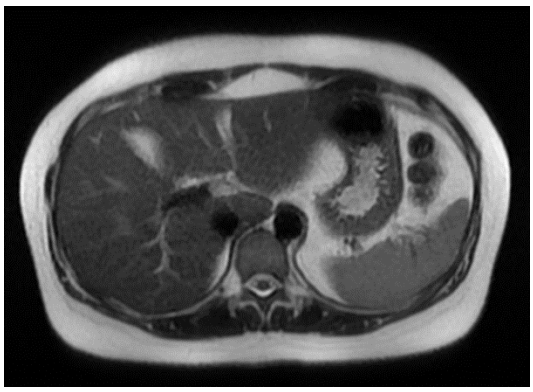


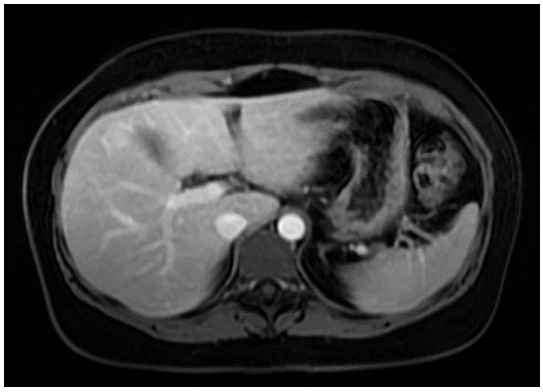
Typical enhancement patterns of hepatic lesions. Hypervascular lesions are hypodense to surrounding parenchyma on unenhanced images. Nevertheless, even large studies indicate that acquisition without contrast medium can detect only an additional 5% of lesions. Hypovascular hepatic lesions are generally indistinguishable from surrounding parenchyma on unenhanced images. Hemangiomas have a pathognomonic enhancement pattern that spreads from the periphery of the lesion toward its center ("iris diaphragm sign").

MRI Sequences

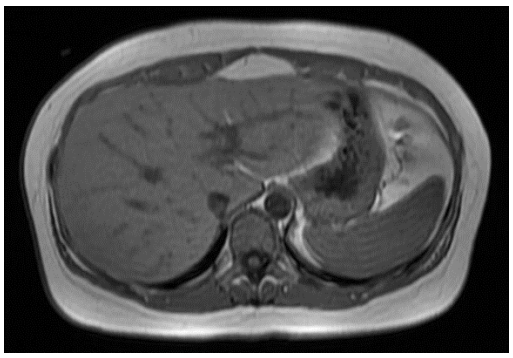
Many variations exist, but a standard protocol might look like:

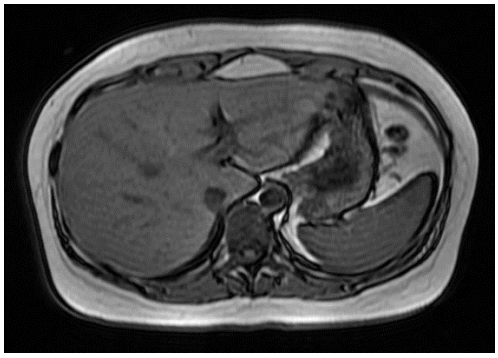
- **T2 weighted**
  - ***plane:*** **axial and coronal**
  - ***sequence: e.g.*** **T2 HASTE and T2 fat-saturated (TSE)**
  - ***purpose:***
    - **T2 HASTE: rapid acquisition images with an anatomical overview**
    - **T2 fat-saturated: longer acquisition that is more susceptible to motion; important to assess T2 signal of focal liver lesions**


Axial T2


Axial T1 C+ Fat sat

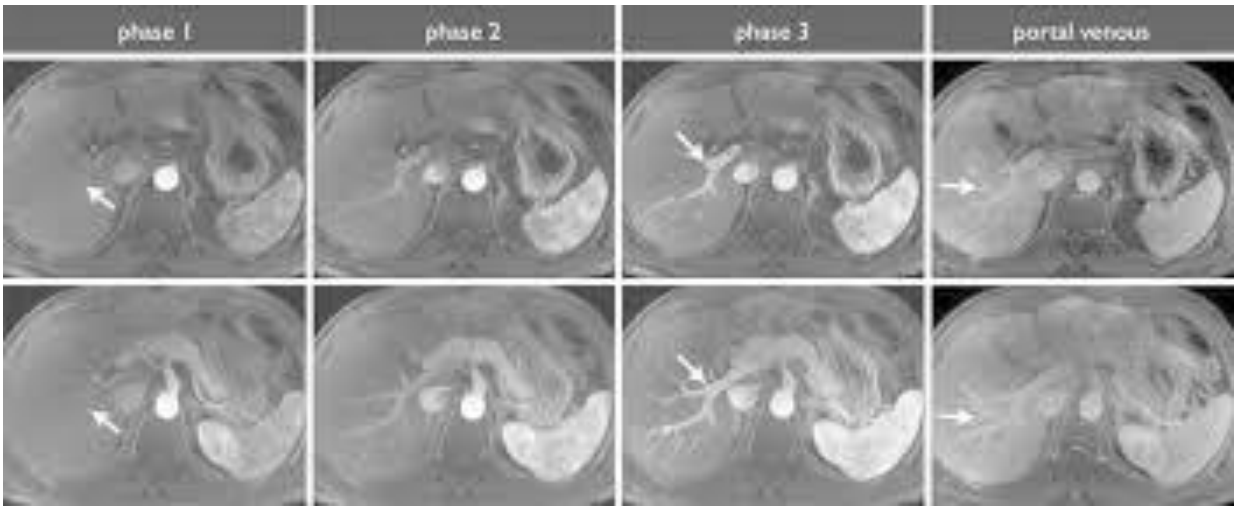
- **T1 weighted**
    - ***plane:*** **axial**
    - ***sequence:*** **T1 in-phase and out-of-phase (<u>IP-OOP</u>), T1 fat-saturated**
    - ***purpose:***
        - **IP-OOP: assess for <u>fat-containing liver lesions</u> and <u>hepatic steatosis</u> (OOP signal drop); IP signal drop is usually seen in <u>iron deposition</u>**
        - **T1 fat-saturated: assess for lesions with intrinsic <u>hyperintense T1 signal</u> (e.g. hemorrhage, melanin, and proteinaceous debris)**


Axial T1 inphase


Axial T1 out of phase

- **Diffusion-weighted imaging (DWI)**
    - ***plane:*** **axial**
    - ***sequence: fat-saturated single-shot diffusion-weighted EPI***
        - **purpose:**
            - **liver masses, like hepatocellular carcinoma, metastasis hepatoblastoma, solid part of undifferentiated embryonal sarcoma in children or HCC**

- **Post-contrast sequences**
    - **T1 2D or 3D gradient-echo sequences (e.g. VIBE) at**
        - **arterial phase: 20-30 seconds**
        - **portal venous phase: 60-70 seconds**
        - **equilibrium phase: 3-5 minutes**
        - **hepatobiliary delayed phase: 10-30 minutes (after gadoxetate, but if gadobenate has been given its 45-60 min) with and without fat sat**
        - **later delayed phase: 1 hour +/- 3 hours in some institutions**
    - **subtracted images are useful in the evaluation of lesions with intrinsic high T1 signal**



Example of triple-phase MRI acquisition with axial slices through the liver hilum (top row) and axial maximum intensity projection images (bottom row). During the angiographic phase, the arterial system is opacified (phase 1, white arrow), without any opacification of the portal venous system. During the early arterial phase, the portal vein system begins to opacify (phase 2). During the late arterial phase, the portal vein is fully opacified (phase 3, white arrow). Lastly, during the portal venous phase, the hepatic veins are opacified (portal venous, white arrow)

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Ref:

https://www.researchgate.net/?_tp=eyJjb250ZXh0Ijp7ImZpcnN0UGFnZSI6Il9kaXJlY3QiLCJwYWdlIjoiX2RpcmVjdCJ9fQ

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