KREP 2025

KARNATAKA RADIOLOGY EDUCATION PROGRAM

Anatomy and Applied Radiology – Pancreas-3

MRI

A normal pancreas MRI protocol typically involves obtaining T1-weighted and T2-weighted images, including 2D and 3D MRCP, and potentially diffusion-weighted imaging (DWI) and gadolinium-enhanced sequences to evaluate the pancreatic parenchyma and ductal system.

Key MRI Sequences:

- **T1-weighted images:**
    - **Gradient-echo (GRE) sequences: These are used to assess the pancreatic parenchyma, including fat-suppressed sequences to improve visualization.**
    - **3D-GRE: Used for multiplanar imaging and thinner slices (3mm).**
    - **Pre- and post-gadolinium imaging: Allows for assessment of pancreatic enhancement patterns, which can help differentiate normal tissue from pathology.**

- **T2-weighted images:**
    - **Axial and coronal sequences: These help to visualize the pancreatic duct and surrounding tissues.**
    - **Turbo spin-echo (TSE) or variants: Used for T2-weighted imaging.**

- **MRCP (Magnetic Resonance Cholangiopancreatography):**
    - **2D and 3D MRCP: Essential for evaluating the pancreatic and biliary ductal systems.**
- **Diffusion-weighted imaging (DWI):**
    - **Axial DWI: Can provide information about tissue diffusion, which can be helpful in characterizing pancreatic lesions.**
- **Gadolinium-enhanced sequences:**
    - **3D-GRE multiphase acquisition: Allows for assessment of pancreatic enhancement patterns at different phases.**

Other Important Considerations:

Patient positioning: Patients are typically scanned in a supine position with the head towards the magnet.

Coil placement: A body coil is used to cover the upper abdomen, ensuring good signal from the pancreas.

Breath-hold: Breath-hold techniques are used to minimize motion artifacts, especially for T1-weighted and T2-weighted images.

Patient preparation: Patients should be NPO (nothing by mouth) for several hours before the MRI examination.

Oral contrast: In some cases, oral contrast agents may be used to improve visualization of the pancreatic duct and surrounding tissues.

Intravenous contrast: Gadolinium-based contrast agents are used to enhance the visualization of the pancreas and surrounding tissues.

Normal Pancreatic Appearance on MRI:

- **T1-weighted images:**

The pancreas demonstrates high signal intensity on fat-suppressed T1-weighted images.

- **T2-weighted images:**

The pancreas demonstrates intermediate signal intensity on T2-weighted images.

- **MRCP:**

The pancreatic duct should be visualized as a tubular structure, extending from the tail to the ampulla.

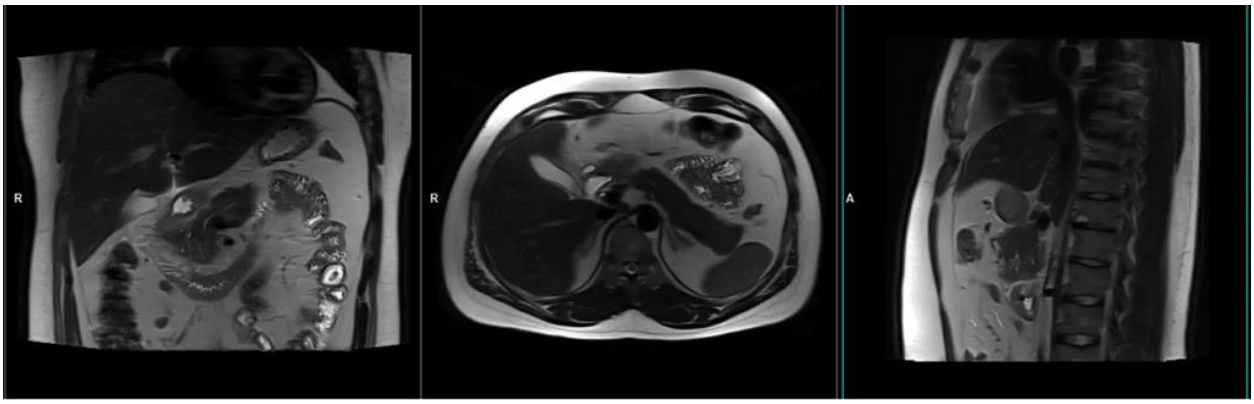
- **Gadolinium-enhanced images:**

The pancreas demonstrates a uniform capillary blush on immediate post-gadolinium images, which renders it markedly higher in signal intensity than liver, neighboring bowel, and adjacent fat.

Recommended MRI Pancreas Protocols, Parameters, and Planning

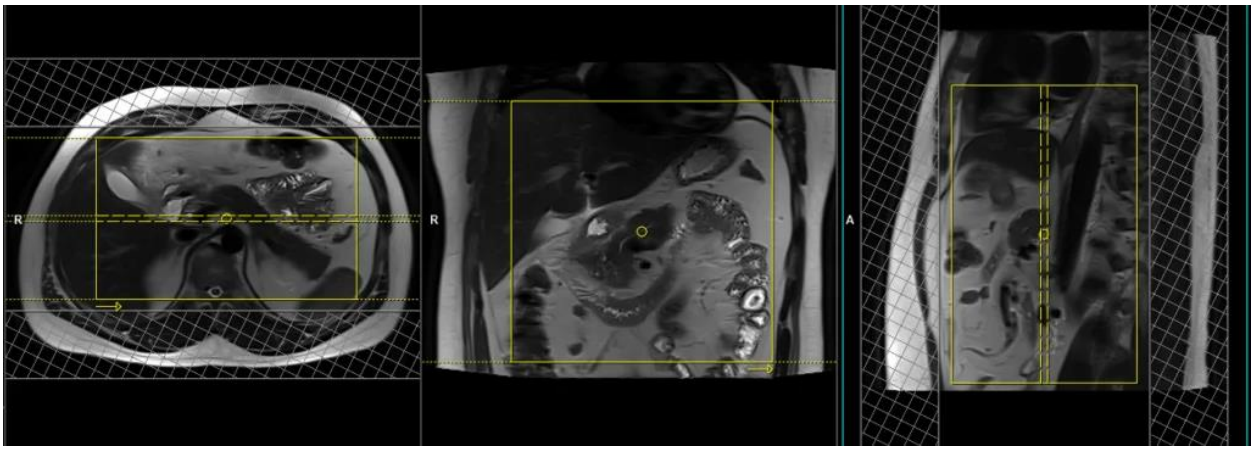
MRI PANCREAS LOCALISER

To localize and plan the sequences, it is essential to acquire a three-plane T2 HASTE localizer initially. These fast single-shot localizers have an acquisition time of under 25 seconds and are highly effective in accurately localizing abdominal structures.



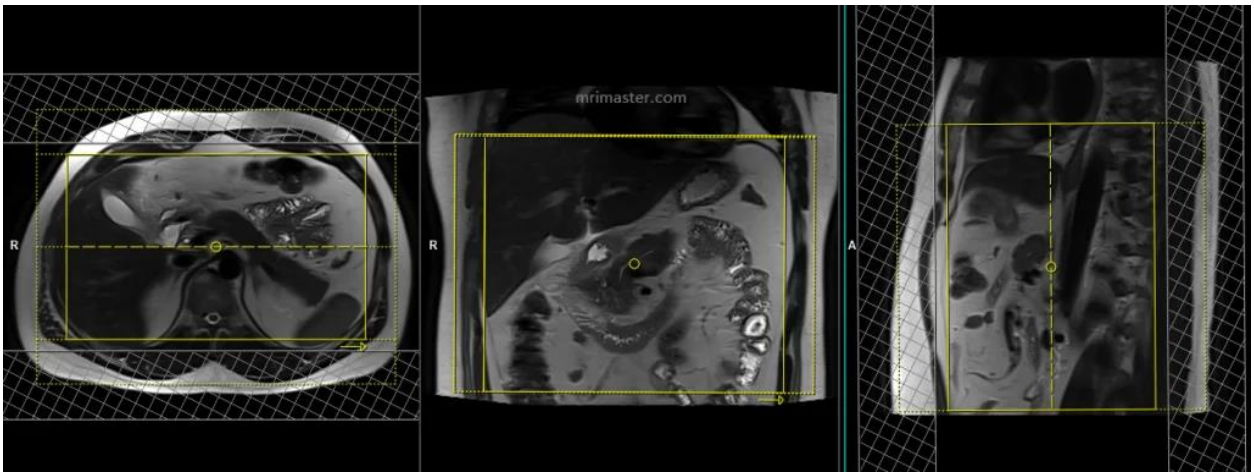
2 HASTE CORONAL 4MM SFOV

Plan the coronal slices using the axial localizer and position the block horizontally across the abdomen as shown. Verify the position in the other two planes. Establish an appropriate angle in the sagittal plane, aligning it vertically across the abdomen. Ensure that the slices adequately cover the entire pancreas, extending from the anterior abdominal wall to the vertebral body. The phase direction should be from right to left to minimize ghosting artifacts from the lungs and heart. Employ phase oversampling to prevent wrap-around artifacts. Additionally, consider adding saturation bands at the top and bottom of the block to minimize artifacts caused by fat signal, arterial pulsation, and breathing. Instruct the patient to hold their breath during image acquisition.



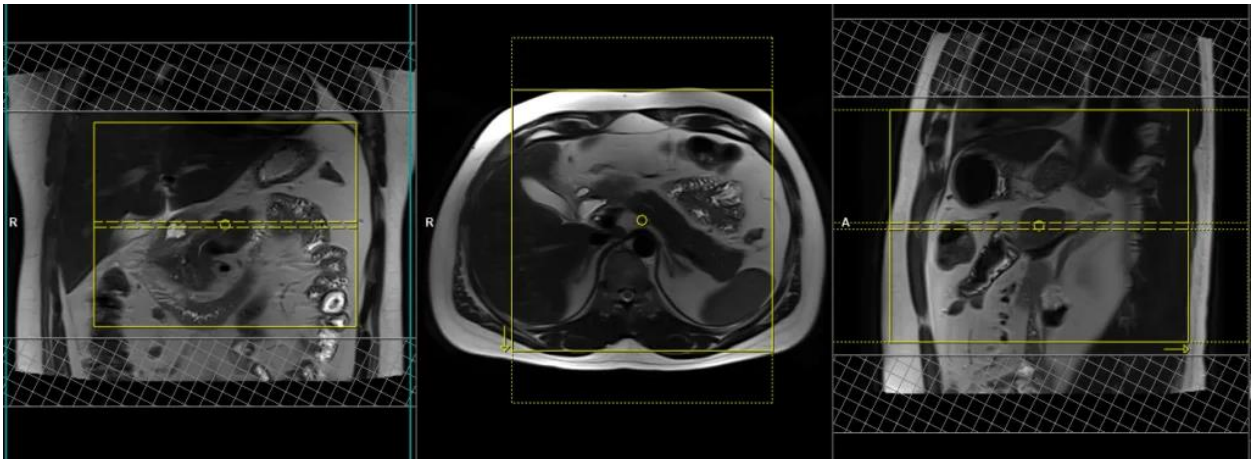
T1 VIBE DIXON CORONAL 3MM SFOV

Plan the coronal slices using the axial localizer and position the block horizontally across the abdomen as shown. Verify the position in the other two planes

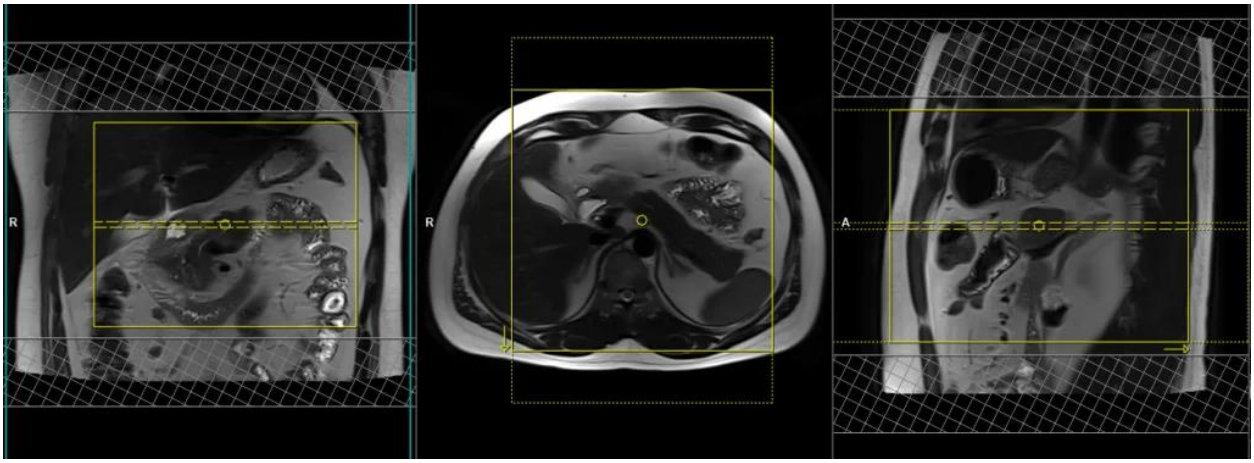


SMALL FOV T2 TSE\HASTE BREATH HOLD 3MM

Plan the axial slices on the coronal breath-hold images and position the block horizontally across the abdomen as shown. Verify the positioning in the other two planes. Establish an appropriate angle in the sagittal plane, aligning it horizontally across the abdomen. The slices must be sufficient to cover the entire pancreas, starting one inch above the pancreatic tail and extending down to the C loop of the duodenum.

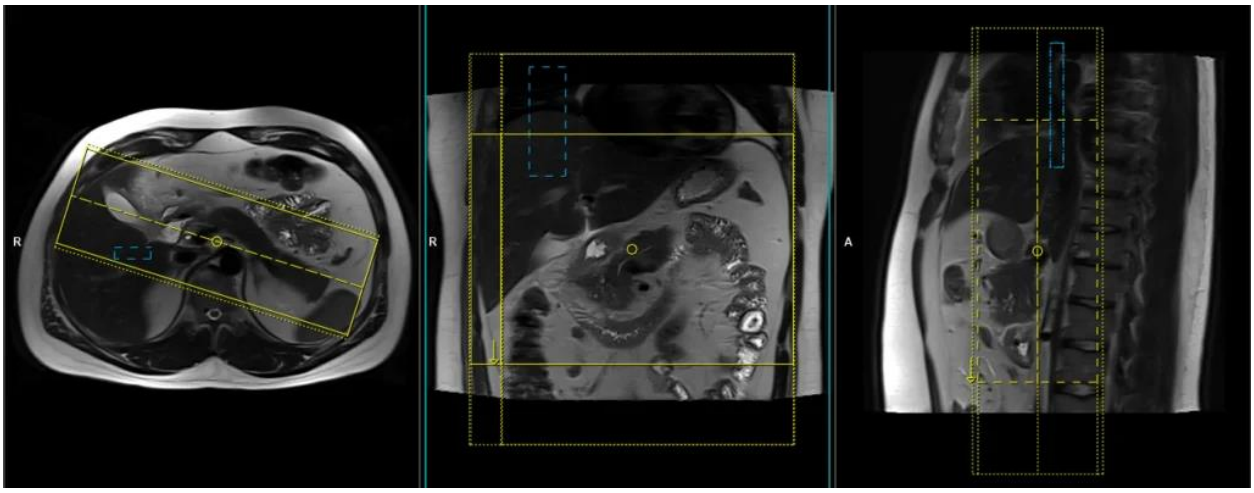


SMALL FOV T2 TSE\HASTE FAT SATURATED BREATH HOLD 3MM

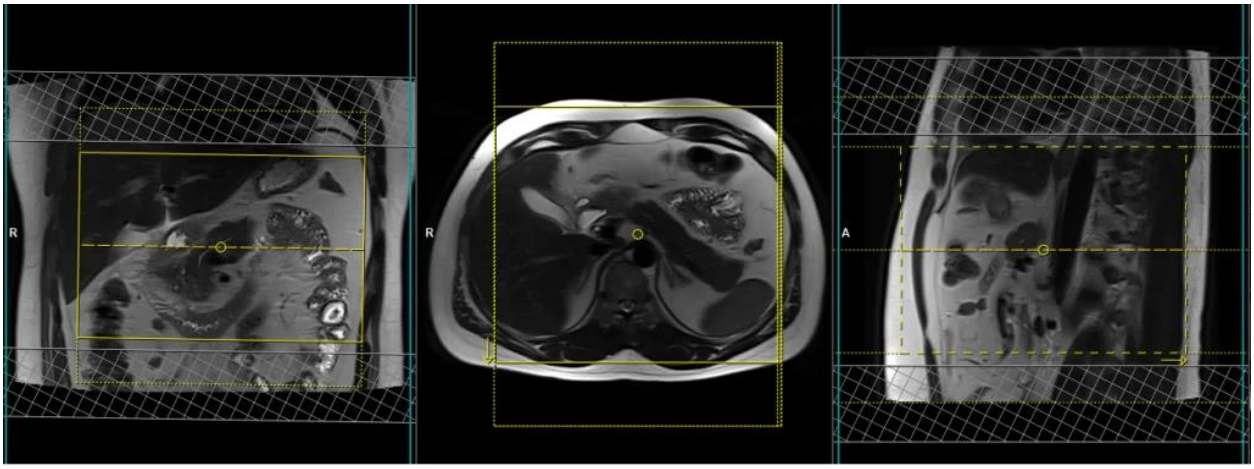


T2 SPACE CORONAL 3D FAT SAT 1MM GATED

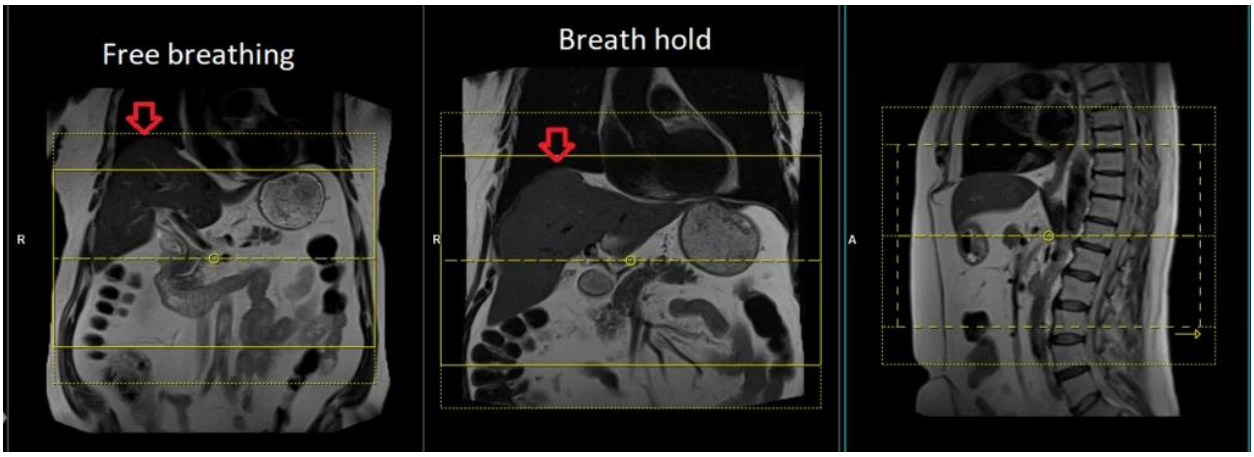
Plan the coronal slices based on the axial images, angling the position parallel to the pancreatic body. Verify the position in the other two planes. Establish an appropriate angle in the sagittal plane, aligning it vertically across the abdomen. Ensure that the slices are sufficient to cover the entire pancreas from head to tail.



T1 VIBE DIXON 3MM AXIAL BH PRE GD(IN-OPPOSED PHASE AND WATER SAT)



Planning must be done in the breath hold HASTE coronal because the diaphragm will push down the upper abdominal organs during inhalation and change the position of pancreas from the initial localizer scans.



DIXON

DIXON MRI is a magnetic resonance imaging (MRI) technique that generates multiple types of tissue contrasts within a single image. It separates the signals from fat and water using a combination of imaging sequences and mathematical algorithms. By acquiring images with different echo times, DIXON MRI can produce various types of contrast, including in-phase, out-of-phase, fat-only, water-only, and combined fat-water images. The in-phase and out-of-phase images reveal subtle changes in fat-water ratios, while the fat-only and water-only images isolate the respective tissue components. Because DIXON produces three types of scans in one, there is no need to perform additional in and out-phase imaging.

CONTRAST ADMINISTRATION AND TIMING OF SCANS

GUESS TIMING TECHNIQUE:-

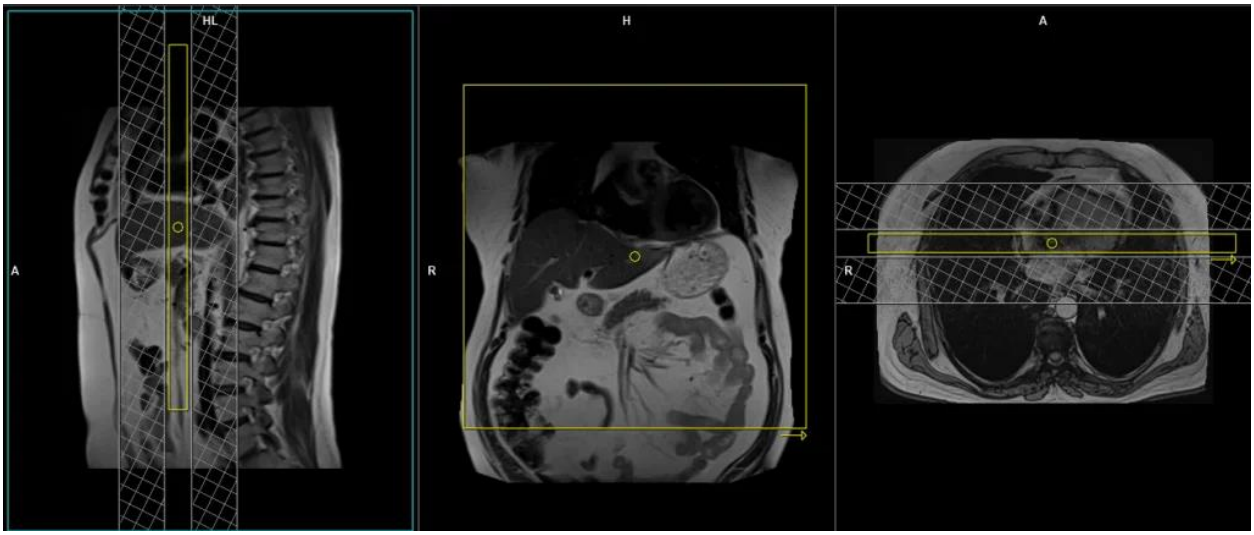
This is one of the simplest methods. It works by estimating the time it takes for contrast to travel from the site of injection to the vascular structures of the liver. This technique is highly dependent on factors such as the site of contrast injection, patient's age, cardiac output, and vascular anatomy. Generally, it takes about 18-25 seconds for the contrast to travel from the antecubital vein to the abdominal aorta and 45-60 seconds to reach the portal veins. Therefore, the first acquisition of the dynamic sequence should begin within 20 seconds of contrast administration.

CARE BOLUS TECHNIQUE:-

The care bolus technique is the most commonly used method for bolus detection. This technique involves employing a coronal fast gradient refocused sequence to obtain real-time images every second through the vascular structure of interest, typically positioned over the heart. By monitoring the arrival of the contrast bolus in the heart, the operator can then switch to the centric 3D dynamic sequence for further imaging.

PLANNING CARE BOLUS

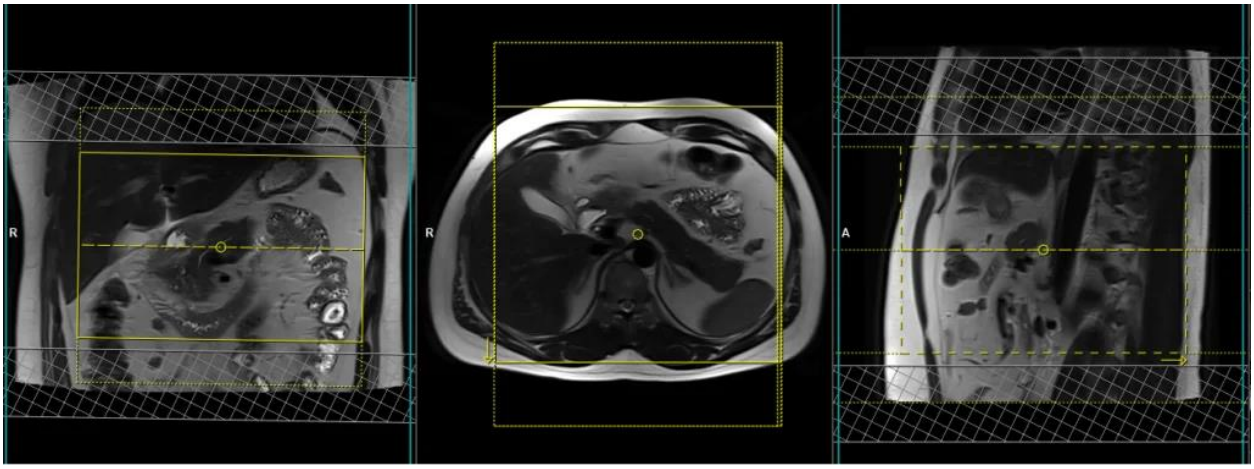
Plan the coronal care bolus slice on the sagittal plane. Position the block over the mid-heart and angle the slice parallel to the ascending aorta. Verify the position in the other two planes. Determine the suitable angle in the axial plane, aligning it horizontally across the heart. To reduce artifacts caused by breathing and heart motion, utilize a saturation band on both sides of the block.



Care bolus scans should commence one second before contrast administration. The operator can then observe the scans in real-time and monitor the arrival of the contrast bolus in the heart. Once the contrast reaches the heart, the care bolus should be promptly halted, and the patient should be instructed to hold their breath before initiating the centric 3D dynamic sequence.

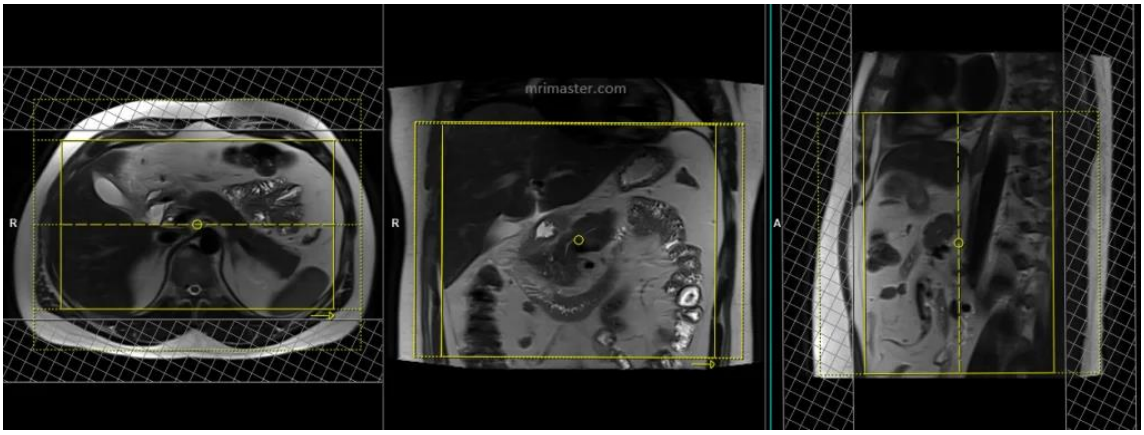
T1 VIBE DIXON 3D FAT SAT AXIAL BREATH HOLD DYNAMIC 2 RUN POST GD

Plan the axial slices on the coronal breath-hold images and position the block horizontally across the abdomen as shown. Verify the positioning in the other two planes. Establish an appropriate angle in the sagittal plane, aligning it horizontally across the abdomen. The slices must be sufficient to cover the entire pancreas, starting one inch above the pancreatic tail and extending down to the C loop of the duodenum. The phase direction should be from right to left to minimize ghosting artifacts from the anterior abdominal wall. Use phase oversampling to prevent wrap-around artifacts. Consider adding saturation bands at the top and bottom of the block to minimize artifacts caused by fat signal, arterial pulsation, and breathing. Instruct the patient to hold their breath during image acquisition.



A dynamic T1 VIBE DIXON 3D sequence comprises two VIBE 3mm 3D scans with a 15-second delay between the first and second acquisitions. The first scan captures the arterial phase, while the second scan captures the venous phase. The timing of each scan is crucial, particularly for the arterial and venous phases. A proper arterial phase acquisition should exhibit noticeable enhancement of the hepatic arteries, pancreas, and spleen, without any enhancement of the hepatic veins.

T1 VIBE DIXON CORONAL 3MM SFOV POST GD

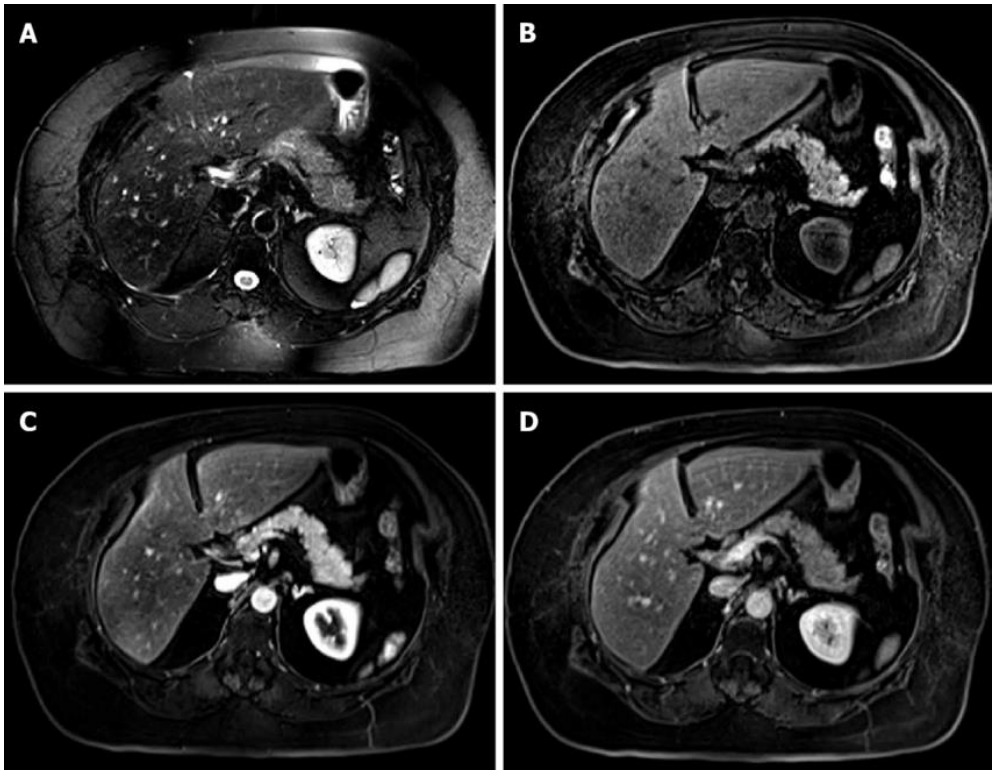


To summarise MR of Pancreas

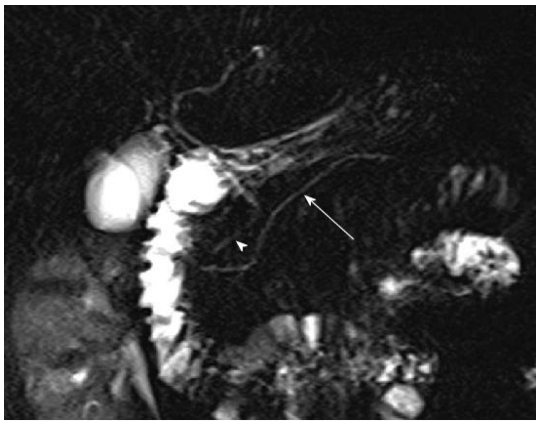
Magnetic resonance imaging (MRI) with cholangiopancreatography (MRCP) has emerged as a reliable tool for accurately characterizing pancreatic pathologies. The superior soft-tissue and contrast resolution inherent to MRI makes it a superior test for assessing the morphologic features of pancreatic tumors particularly in pancreatic cysts. MRCP provides excellent 2-dimensional (2D) and 3-dimensional (3D) depiction of the pancreatic duct anatomy and its abnormalities in patients with pancreatitis as well as neoplasms.

Technique

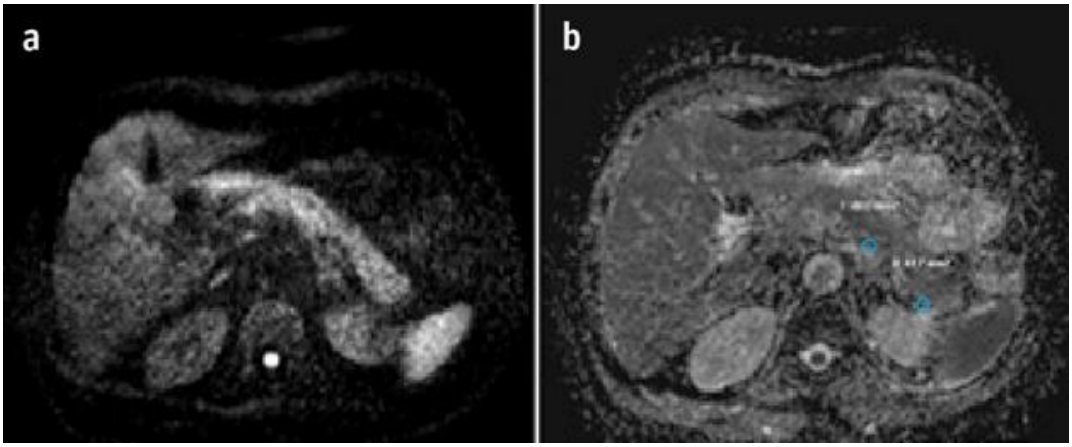
Typical imaging sequences used include axial T1-weighted images, with and without fat saturation, using breath-hold or gated respirations. A complete evaluation of the pancreatic parenchyma and pancreatico-biliary ductal system can be performed with the following sequences: T1-weighted gradient echo, T2-weighted (T2W) axial, and coronal sequences, either fast spin echo (FSE) or turbo spin echo(TSE), 2D and 3D MRCP; and T1-weighted 3D gradient-echo before and after gadolinium. To adequately visualize the gallbladder and to assess the exocrine response to secretin, the patient should ideally be fasting for 4 hours. Negative oral contrast is administered to reduce the signal from the overlying stomach and duodenum. Axial and coronal T2 images with and without fat saturation should also be obtained.Dynamic postcontrast images should be obtained 25, 70, and 120 sec after the gadolinium contrast injection. Ideally, field strength should be≥ 1.0 Tesla with fast imaging sequences. A standard pancreatic protocol also includes MRCP images for further evaluation of pancreatic ductal abnormalities. The MRCP sequence can be obtained as 2-dimensional (2D) or a 3-dimensional (3D) acquisition. 3D MRCP produces high resolution images of the pancreato-biliary ductal anatomy as the thin sections without slice gap of a 3D technique allows better assessment of small stones, side branches of the main pancreatic duct, and intrahepatic bile ducts. The 2D MRCP is acquired either as a thick-slab, single-shot,fast spin echo T2W sequence or a multisection, thin-slab, single shot FSE T2W sequence. The 3D fast spin echo sequence can either be acquired as a series of breath holds or during free breathing. Secretin MRCP is a modified MRCP sequence, which entails administration of secretin to stimulate the exocrine function of the pancreas. Secretin MRCP is useful in assessment of complex ductal anomalies and to quantitatively or semiquantitatively assess the exocrine function of the pancreas



Normal pancreatic appearance on magnetic resonance imaging. A: Axial single-shot turbo spin-echo T2-weighted (HASTE) image with fat-suppression; B: Axial pre-contrast 3D-GRE T1-weighted image with fat-suppression. Axial post-Gadolinium 3D-GRE T1-weighted image with fat-suppression during the hepatic arterial-dominant (C) and hepatic-venous phases (D). The pancreas demonstrates low T2 signal intensity (A) and high T1 signal intensity on pre-contrast images (B) reflecting high protein content of the exocrine gland. The pancreas demonstrates maximal enhancement on hepatic arterial-dominant phase (C); which fades on subsequent phases; reflecting a normal capillary blush.

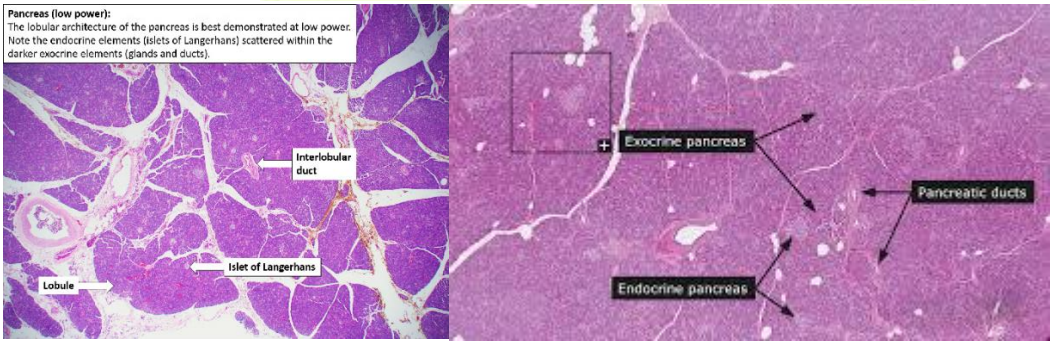


Normal magnetic resonance cholangiopancreatogram.



Apparent Diffusion Coefficient (ADC): A normal pancreas will have a relatively high ADC value,
Signal Intensity: On DWI images, a normal pancreas will appear with a bright signal.

Percutaneous Biopsy: A needle is inserted through the skin and into the pancreas, guided by ultrasound or CT scan images.
Other Methods: In some cases, a biopsy may be performed during surgery to remove the pancreas or a portion of it.



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